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AERO DIGEST, New York

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AERO DIGEST, New York
PLEXIGLAS GLOBES REPRESENTING THE SOLAR SYSTEM AND INCLUDING ETCHED ILLUSTRATIONS OF THE CONSTELLATIONS ARE AMONG THE MANY AIDS TO NAVIGATION INSTRUCTION WHICH HAVE BEEN DEVELOPED BY THE AIR TECHNICAL SERVICE COMMAND.

Maps—Important Equipment for Civilization

By JOHN F. BARKSDALE*

THE MAKING of maps has grown with our increasing population and with the enlarged interests and activities of the Nation, but has in no way kept pace with the need. American business corporations and government agencies have a distressing custom of not authorizing expenditures for mapping until the need is acute for specific purposes. There is then a hectic mobilization of men and equipment and the wastefully feverish activity, which many of us have experienced, to complete the maps by deadline dates. Economists, planners, and engineers have for many years diligently advocated the mapping of many strategic and critical areas. However, those who in the past have controlled the appropriations of funds have never seemed to agree with engineers and economists. There is now, however, an encouraging trend. Some of the more far-seeing and resourceful authorities are securing the appointment of engineers to administrative positions of influence. There is also an increasing number of those who appreciate the fundamental need of good maps, serving on planning commissions, resources committees, and as city managers.

By all present methods of forecasting and planning, it appears that the post-war need for topographic maps and miscellaneous mapping activities will be quite extensive. The planned expansion of many major industries will require some type of good maps before they can effectively proceed. World War II has taught us some very bitter lessons regarding critical materials, and there are definite indications that extensive exploration work will be done to locate sufficient deposits and supplies to insure that the painful experiences of 1941 to 1943 will never happen again. These extensive critical material explorations will first require more good topographic maps. When we look in libraries for textbooks and technical literature on the science and art of map making, we find that comparatively little has been written, especially regarding map compilation, accuracy standards, and reproduction methods. And yet, surveying and mapping should prove to be profitable fields for the many young engineers who wish to cash in on their wartime mapping experience and training.

The sight of hundreds of machines and thousands of men working together on large construction projects is spectacular and has a very stirring appeal for all of us. The importance of present day construction projects, completed with such phenomenal speed, in no way should be discounted. However, the trained caution of our economists and planners, beginning to assert itself, increasingly calls our attention to other and basic needs which the engineer should fill. Professional and industrial experience has amply demonstrated that accurate maps are basic engineering equipment. A good topographic map not only serves the present, but also is in stand-by status for the needs of unforeseen industry and for construction projects yet many years in the future. The threat of obsolescence to good maps is not so great as for many other types of engineering work, where the discovery of new sources of material or invention of new equip-

* Senior Civil Engineer, Tennessee Valley Authority.

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ment take an increasingly heavy toll of current works. We can well afford to make basic maps for the future.

The accurate mapping of a continent on the earth's surface is truly as important an engineering undertaking as the girdling of it with a gigantic highway system or the harnessing of its rivers with dams. We have come a long way since the "Red Brush Surveyor" days. Modern surveying and mapping is accomplished by means of airplanes, special wide angle lenses, giant copying cameras, and many other items of the latest scientific and precision equipment. A young man can find full and complete expression for his engineering or scientific training in this profession. The maps can be used by both present and future generations for the innumerable engineering projects and scientific investigations which a complex modern civilization requires, as well as for military emergencies. It should be borne in mind by all of us that an accurate map is of as definite service to civilization as any other engineering achievement.

* * *

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The Use of Plane Coordinates in Property Surveys

By WM. B. HOKE *and* C. A. MONROE

EDITOR'S FOREWORD

In the April 1945 issue of SURVEYING AND MAPPING a Prize Competition was announced on "The Use of Plane Coordinates in Property Surveys," sponsored by W. N. Brown, Inc., of Washington, D. C. The competition closed on September 1, 1945, at which time fourteen entries had been received by the Secretary. The Committee of Judges, consisting of Messrs. Carroll F. Merriam, Chairman, W. N. Brown, and S. A. Bauer, awarded the first and second prizes to William B. Hoke and C. A. Monroe, respectively. In accordance with the rules of the competition their papers are being published in this issue. Other papers, or excerpts therefrom, will be published in future issues of SURVEYING AND MAPPING.

The American Congress on Surveying and Mapping is gratified by the interest which this Competition has stimulated among practicing surveyors, and hopes that the publication of these papers will encourage further comments and discussion. The Congress would welcome prize sponsorships by others on various aspects of surveying and mapping.

WM. B. HOKE.*—There are a number of techniques, including plane coordinates, available to the engineer in surveying an individual tract, most of which are known and used by every practitioner according to his fancy and the particular problem encountered. But when that survey must take its place in a larger plan, or a group or chain of properties must be surveyed, or a very large subdivision must be made, then it is that the system of plane coordinates is worth consideration.

Enthusiastic adherents of this form of surveying, however, sometimes fail to mention some cold hard facts, which, if known by the casual user, would prevent disillusionment and distrust of a very practical and economical method of mapping, computing, and recording any size tract whatever.

To begin with, the need for careful planning over a large area, first grade and specialized equipment, carefully trained personnel, and not immediately usable effort puts the responsibility for creating and maintaining a coordinate system in the lap of the larger communities, the counties, or the state. Individually oriented, overlapping, or superimposed systems, each with its own origin, can involve every one in a maze of conversion formulas and consequent distrust of the whole business. It is better to extend or amplify an existing system, if good, than to create a new one of purely local significance.

Assuming that a system of plane coordinates has been established by approved methods and satisfactory accuracy, these advantages are immediately apparent:

1. Individual surveys, scattered about the zone of operations, will take their proper place in an overall picture. Whenever necessary or convenient, the missing portions of the commercial or political unit can be added, with the assurance that the pieces will fit together as in a jig-saw puzzle. Pertinent in-

* Licensed Professional Engineer and Land Surveyor; Chief Computer, Bureau of Plans and Surveys, Department of Public Works, Baltimore, Md.

formation can be extracted from each survey or mapped area and compiled into whatever form the needs of the moment demand. Thus, an individual development may fit into the municipal picture, the municipal into the county and state, and the state into the national scene with a resulting harmony of effort and considerable saving in time and expense to all cooperating parties.

2. No form of mapping, including the aerial, has as yet been devised without some form of ground control being necessary. As in the case above, maps of any desired accuracy may be begun in any portion of the area covered by coordinates, many parties may be working at once or the map may be completed piecemeal and over a long period of time without fear of distortion.

3. In any political subdivision where plane coordinates have been legally understood and accepted, the describing and filing of deeds, plats of acquisition and condemnation, development plans and the records of public service organizations have been considerably simplified.

4. The necessity of maintaining monuments, pipes, posts, or other calls is greatly diminished if they have been accurately referenced to the control system. Those who have been charged with reproducing property lines after extensive building and development operations have changed the landscape over many acres, where cuts or fills of 30 or more feet are not uncommon, can appreciate a method of re-establishing those lines in a manner acceptable to all parties concerned.

5. Lastly, and important to the practising surveyor, the need for adhering to the outline of a tract by following old hedgerows, tortuous courses, centers of streams, or other difficult terrain is modified by random traverses, selected for convenience, together with simple computations. As an instance, a properly co-ordinated location of the markers at each end of a line, no matter how long, gives a better bearing and distance of that line than most surveyors can take the time or have the equipment to measure. The determination of one such line of a tract, permits the co-ordination of all points on the outline and saves hours of search for other corners and possible errors. Those who have wrestled with the problem of reconciling the ever changing and hard to determine magnetic bearings, accept with relief the unchanging and accurate azimuths which are an integral part of the good plane coordinate system.

If all the foregoing should be summarized in the fewest possible words, the conclusion would be permanence of record and accuracy of results over the greatest possible area.

Lest it be considered that the mere decision to create a plane coordinate system would be a cure-all for all the ills of the surveyor and an infallible method of operation, a word of warning should be inserted here. It is obvious that the accuracy of the ultimate use to which plane coordinates may be put is directly dependent on the accuracy of the triangulation and traverse system which creates the control net. Traverses with an error of 1 part in 1000 cannot be used to determine exact positions over any area beyond the range of a single point. On the other hand, surprising results can be obtained through the use of properly distributed control points of a guaranteed accuracy of 1 part in 50,000. Secondary or tertiary traverses must have a correspondingly high ratio of error depending on the use to which they are put.

Control points can be shifted or destroyed as easily as other landmarks and in urban areas seem to suffer undue disturbance, mainly due to their exposed

position. A program of constant checking and replacement is necessary to maintain the original standard.

Any area theoretically controlled by traverses, but in which the stations are sparsely scattered, puts added work and responsibility on the engineer in tying a small survey to those stations and with proportionate increase in his costs.

The conclusion is then, that any economic or political subdivision of the United States willing to expend the money and effort in creating and maintaining a good plane coordinate system has given the private practitioner a new and useful tool which he gratefully accepts but also permits responsible authorities to correlate every bit of pertinent information which is then available to public and private surveyors alike. The hours saved, which would otherwise be spent in attempting to reconcile conflicting information, would alone pay for the installation of plane coordinates.

C. A. MONROE.*—Simply stated the plane coordinates of a point are the distance north or south of an east-west reference line and the distance east or west of a north-south reference line. From this simple statement it is obvious that at the intersection of the two reference lines the coordinates are zero. With this premise in mind expand the principle into a system of coordinated points, each point in turn being referenced to the same, or common north-south and east-west lines, and you have the most convenient and practical tool in surveying, outside of the actual physical instruments and tools used in making surveys.

Undoubtedly every engineer and surveyor knows the principles of plane coordinates but perhaps all do not know or realize with what great facility they can be used in surveying.

Consider the use of plane coordinates in establishing the boundaries of properties of almost any size—small or large—but particularly large tracts of land. The first step in determining the boundary of a tract of land is to gather together all the available deeds of record of the property itself as well as those of the adjacent properties. These records are compared and studied for agreement. Even in the study of comparative deeds and surveys of record, it is found useful to establish common lines in the various records as a base, or start, for the coordinate system. Then by coordinating the various points of the comparative and common records it is possible to see at a glance almost where and how they differ. The next step in establishing the boundary of the property or tract under consideration is to make an actual, physical survey on the ground with the aid of the records already obtained. Property boundaries are a series of lines physically defined by such objects as fences, hedges, trees, stone monuments, stakes, etc. These objects must be found in the field and the relationship, or position, of one to the other determined by methods of surveying so that the physical boundary can be described and transcribed to a new or dated deed of record. In making the physical survey consideration must be given to the fact that generally properties are covered with trees and scrub growth; streams, ponds, and lakes are encountered; and hills and valleys offer problems in making it difficult, if not impossible, to follow the actual boundary of the pro-

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* Chief Engineer, Levitt and Sons, Inc., Manhasset, N. Y.

perty. Therefore, it is usually more practical and conducive to speedier survey work to run survey traverses at random along lines of least resistance and as near the boundary as possible. From the points of the survey traverse the points or objects on the boundary are tied in and then, by computation in the office, related to each other. To facilitate the office computations in establishing the boundary from the physical survey, it is best to adopt a system of plane coordinates whereby every point of the survey random traverse and every point on the physical boundary are related to common north-south and east-west reference lines. By office computation it is a very simple process to arrive at the final metes and bounds description of the tract by the use of the plane coordinate system.

In the subdivision of small and large tracts of land into smaller plots, or lots, it is practically impossible to compute the dimensions of the smaller plots without the use of a system of plane coordinates. Particularly is this true where the road system meanders about the property in a curvilinear layout, requiring the computation of intersections of straight lines with curved lines. Designating all the lot corners and road points with plane coordinates permits of tying in the subdivision points with random survey points so that the work of actually laying out, or staking out, the property is greatly facilitated. With the use of plane coordinates, the relationship of any point in the subdivision to another is very easily determined—almost as simple as the ratio of one number to another. With this simplicity of relationship in mind, it can be readily seen how easy it is to establish any point from any other two points in the system or to re-establish points that have been lost or destroyed. This should be obvious without further explanation.

Because of the increased use and recognition of plane coordinate systems in all types of surveys and particularly as related to property surveys, there has been a tendency in recent years to authorize, by legislative enactment, statewide plane coordinate systems. These statewide systems have in general, if not wholly, been established by the U. S. Coast and Geodetic Survey of the Department of Commerce. The basic system is established from the nationwide triangulation net with its system of spherical or geographic coordinates. There is an exact relationship between plane and geographic coordinates and so it is simple to set up a plane coordinate system with geographic coordinates as a base. With statewide plane coordinate systems in effect, it is hoped and expected that property boundaries will, in the future, be described in terms of these statewide systems. In some states this is already a fact and in other states, about thirteen or more, legislation has been enacted authorizing a state system of coordinates, but its usefulness has not been practically utilized as yet. The usefulness of these state coordinate systems will be realized more and more as the years go by and surveyors, engineers, lawyers, and others dealing in property conveyances understand their use better through actual experience. All surveyors and engineers should familiarize themselves thoroughly with the usefulness of a coordinate system in all types of survey work but particularly in connection with property surveys—both for their own good and as a professional duty in expounding its merits to others, which will in turn serve to hasten its general use.

Just this year (1945) the U. S. Coast and Geodetic Survey has published Special Publication No. 235, entitled "The State Coordinate Systems (A Manual for Surveyors)." In very clear and simple language it explains the general and

detailed use of plane coordinates. Rather than include any of the text in this article, I would recommend that every surveyor and engineer interested in survey work of any kind should read this publication.* It will make clear that the use of coordinates in surveying is a very simple procedure and not an intricate process. A plane coordinate system is designed so that practicing surveyors can use the same methods of surveying that they have been using, with possibly some refinement in the use of the same instruments they have always used.

I had intended to amplify my article to some extent but since I started it I have received a copy of the above publication. The publication explains much more and better than I could, the value of state plane coordinates, even using 2000 words, so here I stop.

My experience with the use of plane coordinates in property surveys dates back to 1927 in connection with the survey of 10,000 acres of land at Montauk, Long Island. Since then I have used it in practice almost continually, in all types of surveys. It is a remarkable tool in survey work.

* EDITOR'S NOTE.—A review of this publication appeared in the October 1945 issue of SURVEYING AND MAPPING.

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Unusual Surveying—Dam Deflection Study

The survey party shown is establishing a "line-point," before impoundage, on the small emergency spillway appurtenant to TVA's large Fontana Dam in western North Carolina. The two men on the small dam's crest are "lining in" between two monuments, one on each hillside abutment. Those in foreground are occupying one of the monuments with theodolite. High precision of the "lined-in" point was attained by numerous repetitions, centering theodolite by transit set on line nearby, and similar means. In future years this line-point will be periodically resurveyed, and its movement upstream or downstream will be a measure of the deflection of the spillway structure.

A much more elaborate deflection survey system was established on the main Fontana structure and on several other of TVA's full-size dams, making it possible to determine the movement of individual sections of each such dam. Precise elevations were also determined, for measuring settlement.

Jotting

(THE NEW CARTOGRAPHY)

Nightmare—by Swinburne out of Lynam—followed hard on the heels of Hypercriticism—by Diehards out of Sweet Reason.

In days of old, Time without timing
Was lavished on colour and shape:
(Whereas now we write verse without rhyming;
Our metre is naught but a tape.)
In those days, all the arts of Mercator's
Were applied without blemish or fault
To the maps for the Great Expurgator's
Ubiquitous Salt.

Departed the gryphons and dryads;
Submerged are the mermaids, ashamed
To disport for the new Jeremiads,
Whose salmon and shrimps* are inflamed.
In place of meridians convergin'
We have grids by the thousand and three:
They have blackened the "verge" of the virgin,
Sweet Soul of the Sea.

No time for the "casing" of highways,
Now Man is replaced by Machine.
A forest of "pecks" show the byways,
Mid jungles of emerald green.
Yet the depths are not plumbed of this fashion:
We come to the bitterest of pills
When Purple—once Pigment of Passion—
Lies thick on the Hills.

All roads, if you please, lead to ROMA.
All craftsmen of brush and of pen
At such lingos must earn a diploma
As slaves of the P.C.G.N.
Yet shall these drab days turn to morrows,
And nereids return as of yore,
When we come to an end of these horrors:
The Horrors of War.

—*Empire Survey Review.*

* Less well known as submarine layering on coastal air maps.

World Projections for the Air Age

By DR. S. C. GILFILLAN

RESEARCH ASSOCIATE, THE UNIVERSITY OF CHICAGO

SO LONG as the poles formed the axis of their attention, people seldom realized how conveniently the world has been laid out for cartography, and for transportation now that the air age arrives. It has indeed been often noted that nearly all the world that matters can be put in one hemisphere (see fig. 1), which includes 90 percent of the land without Antarctica, 94.4 per cent of the population, 95 percent of the income, and 95.6 percent of the manufacturing output. Its center is in northern France—perhaps Paris, or near LeMans, at O° longitude and 48°N. latitude, would be the best point to take. This hemisphere is our world, practically all the world that matters, if we but add two or three minor extentions—a triangle of South America from Rio and Lima southward to Cape Horn, Indonesia followed by the Anzac lands, and finally Hawaii. Most of the rest, which we cannot put into our supplemented hemisphere, is the rarely traversed parts of the Pacific and Antarctic oceans, and Antarctica.

Our world-that-matters is further concentrated and simplified in its transport routes by strong concentrations in two areas of high civilization, northwest Europe and northeast United States, carrying with them the mass of wealth, production, population, imperial capitals, and transportation. This concentration is not accidental, but arises because the basic desiderata for high civilization occur together only in these two areas. Those necessities are: 50°F. (10°C.) mean annual temperature[1], a major storm belt, a broad land, and water transport. Everywhere save in those two areas two or more of the basic necessities are lacking.

It may not be realized how much the world has been reorganized, and its needed map changed, by the new kinds and quantity of transportation and communication offered by the newest aviation, radio, and wealth level. Already the oceans and Bering Strait are being flown wholesale; soon we may expect most passengers and all first class mail and much express between continents to go by air, and in far greater volume than hitherto. Previously we have thought of water transport as one thing—ships, commonly plying an ocean—and land transport as quite another and separate thing, a matter of trains, railways, automobiles, and highways. And similarly with communication—it was either carried by these same, or went by wires on land, and by separate submarine cables across the sea. But now the airplane and radio can leap both land and sea, unbound by the old pathways, creating the shortest possible new ones, and not necessarily stopping at the lines between nations, nor even between land and sea.

Our larger, multimotored, more airworthy planes fly longer and safer hops, high in the substratosphere where storms are rare, the clouds are below and the lights of heaven shine almost constantly, while the specialized navigator, steadily figuring from them and from radio-goniometry, plots an unerring course. Progress in longer hops is especially conducive to great circle courses, speed and

[1] GILFILLAN, S. C.: The Coldward Course of Progress, *Political Science Quarterly*, vol. 35 pp. 393 to 410, chart on p. 395.

safety, and is significant to our cartographic purposes. If our plane need not refuel in the Aleutians or Iceland or Newfoundland, what matter their low-level fog and storms and lack of local traffic?

Maps for the Air Age

The cartographer's upshot is that we can no longer be content with a continental map when thinking of land transport, nor with an oceanic map when thinking of water routes, nor with the usual interrupted projections nor pairs of hemispheres, but need a world map with land and sea articulated as one. There should not even be a break in Bering Strait or central Asia, as with the familiar world maps, but only where traffic does not go. A striking, but freakish example of such a land-sea map was the recent one that showed no seacoasts, but only the world's cities. Another consequence of the indifference of aviation to land or sea should be the standardization of sea-miles and land-miles, probably the latter as more usual, although kilometers would be better.

What sort of a world map will best fit and serve these facts of the new travel and communication in the hemisphere-that-matters, with its two great centers, one of them at the very geographic center of the hemisphere? It would be a map which would (1) center in that hemisphere and its outstanding northwest European region; (2) show all the airline radii from this center approximately truly and straight, traversing the right spots *en route*, and with all distances along these radii correct; (3) show the second, northeast United States center with its radius-routes as near correct as may be—or have a second map centered here; (4) show all continents in their correct areas and shapes; (5) show fairly well the relations of the continents to each other, and perfectly along the main air travel routes; and (6) since a projection can show some things truly only by distorting others, sacrifice the parts of the world that matter least. These are the oceans, especially the untraversed waters, the Antarctic continent, and little Pacific and Antarctic islets.

Projections often offered for air age use, but unsatisfactory, are north polar azimuthal ones, either equal-area (Lambert's), equidistant, or orthographic. They share the faults of making their central, best area the north polar ocean, a most unimportant region, even to aviation, and their distortions increase from the Pole, becoming so violent at last that these projections are rarely extended beyond the Equator. A remedy for the last defect was proposed well before 1907, but while frequently offered has never taken on. This which Duchesne called star, floriform, anthomorphic, or leaf-form maps generally consist of a central hemisphere, usually on an equidistant projection, surrounded by four to six triangles on altered and arbitrary projections. He presented a better form, more adjusted to the continents, with three irregular lobes centering in the North Pole, and Goode has further improved this to a very perfect result.[2] But these and perhaps all star-like, interrupted projections save Wray's and Cahill's butterfly map, are at fault for most purposes by their choice of a center. The north polar region has its merits for cartographic simplicity, but it is a poor center of transportation or need for accurate mapping. Even the air routes will not cross it, unless as a tourists' stunt, but will skirt the Arctic Circle, as we show and as is agreed by most students of the problem.

[2] Goode's School Atlas, rev. ed., 1939, p. 2.

A Matter-most Map of the World

There are several other projections possible, new or rather new, and none of them very familiar, which satisfy fairly well the above listed demands especially of the air and radio age. Perhaps the best will be a new map to be presented shortly by Mr. James Wray of the University of Chicago, centered on Paris. Leaving further exposition to its author, we shall present our own Matter-most Map of the World (fig. 1), on somewhat similar principles, drawn and improved by him. It presents Eurasia, North America, and the north shore of Africa in the azimuthal equidistant projection centered on Paris, to 75° thence, and the remaining continents in an equidistant equal-area graticule, spaced from the same center of the world. It is possible that a method of freehand sketching, to unify the two projections and secure better forms, might be an improvement for the purposes of such a map. It is most suitable for a small, sketch-type map for thought purposes, with an overlay of transportation routes, or empire shading, isoplethic (intensity) distributions, or the like, rather than as a large map for reference and catalog purposes and accurate measurement. Wray's and many other projections will serve these. Our basic principle is to show the important things correctly and conspicuously, at the cost when necessary of ignoring or falsifying the unimportant. We believe this principle to be right, even if there be some human inclination to prowl about the odd corners of the world, picking up curious lore.

Our map is not strictly azimuthal; the radii from Paris are straight for 75° and tend to converge thereafter. The lines from Chicago and other distant centers will be distinctly curved in the circumferential direction, as shown; but except from northeast United States and on the America-Asia trunks, such routes will be of lesser importance. A second map centered on Chicago, New York, or San Francisco would be desirable, but not usually worth its cost. True distances over much used routes are important, and somewhat enlarged in the American case, about 1.3 fold in New World routes. True azimuths would seem important only for certain rare radio purposes, but roughly true ones, as here, are of help to foresee great circle travel routes. True azimuths and great circle routes are rarely followed closely in practice, the stops being placed for traffic and many other reasons, and the great circle courses not even followed between stops, but the route adjusted to the weather of each voyage, a matter outside cartography. Similarly the provision of a graticule seems of little interest to the users of such a map; so its necessary omission from the oceans will not be regretted; and for simplicity it may well be omitted from the land too. Small islands are omitted, unless of significance for aviation, when they are placed according to an adjacent continent, or through the central projection which covers the North Atlantic and Arctic Oceans, or they could be placed wherever seems suitable. The definite projections will cover all the world's islands larger than Viti Levu (Fiji) and the Antarctic ones.

Such a map, in textbooks, atlases, and special studies, can well serve many purposes beside the study and teaching of the world's transportation routes and air war and radio relations. The concentration of Euramerican leadership is shown best. With the map's approach to equal area conformality, and its compactness, it is suitable for all sorts of isoplethic and other studies of the distribution of measures and aspects of civilization that do not depend on climate nor oceans—such as population, forms of wealth, occupations, religions, languages,

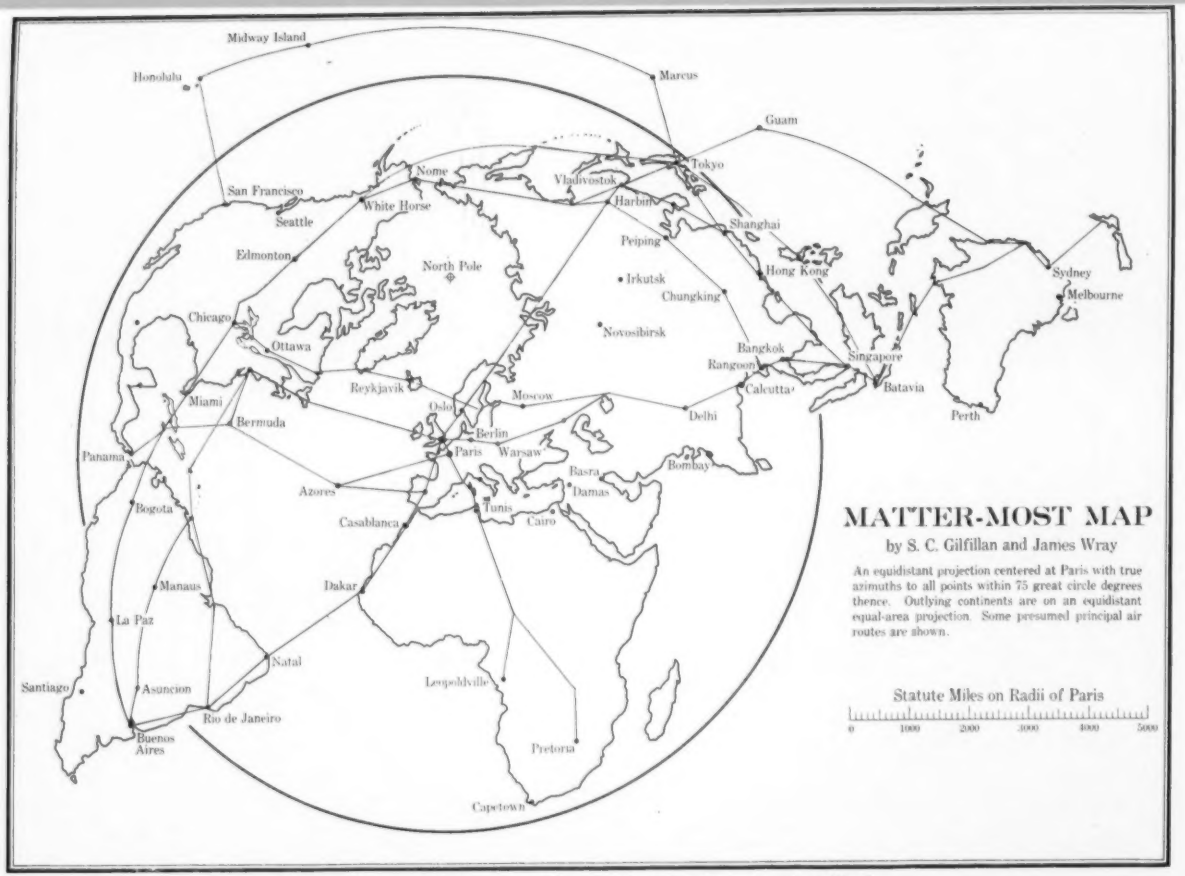


FIGURE 1.—A Matter-most Map of the World centered at Paris.

and mineral resources. Since our map shows better than most the Bering Strait bridge, it covers the prehistoric migration route of flora, fauna, and man; so it is good for showing the distribution of biologic families and human races, with the solidarity of Eurasia-America, and the remote aberrancy of Australasia and South America. On the whole the map seems to have a very wide field for use,

FIGURE 2.—A Doubly Equidistant Projection based on Paris and Chicago.

but above all for elementary studies of world transportation in its relative magnitudes.

A Doubly Equidistant Projection

To be sure, our Matter-most Map has its faults, as all projections must, being efforts to flatten a sphere. The objection most likely to be brought by geographers—but not by the public when used as intended—is the lack of a uniform projection for land and sea.

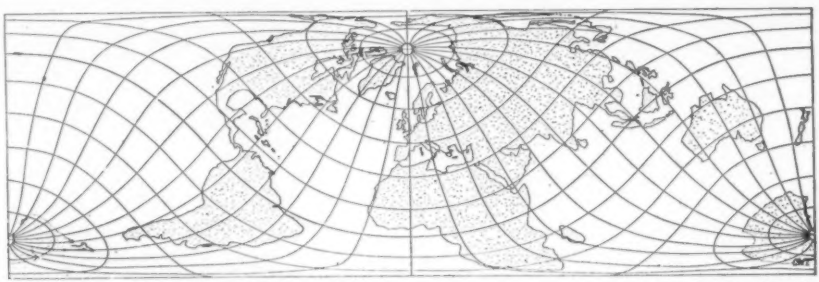
This last objection is satisfied by several other world projections suitable to the air age. Perhaps the best of these will be Sir Charles Close's little known

Doubly Equidistant Projection.[3] Figure 2 presents for the first time this projection with what would seem its most useful centers—the two foci of civilization—Paris and Chicago. It makes a good world map, and resembles and shares all the merits of the others recommended, plus a regular and single projection, although it is not equal-area nor conformal and has considerable distortion of the Australasian outlier, as is evident. However this enables drawing pretty well the America-Australia and other trans-Pacific routes.

While less compact than the Matter-most Map, it can be made the most compact of all, by excluding Antarctica and enclosing all the rest of the land in a vertical rectangle closely fitted.

Other World Maps

The last map (fig. 3) borrowed from Thornthwaite,[4] is another complete mathematical projection on a wholly different principle, yet having the same pur-



C. W. Thornthwaite

Figure 3.—Oblique Cylindrical Equal-area Projection.

poses it presents somewhat the same results. It is an oblique cylindrical equal-area projection, following an idea that goes back to E. Hammer in 1889. The cylindrical projection is an elevation or horizontal projection of the globe upon a circumscribed cylinder, which normally is tangent at the Equator. But the tangent circle could be made any great circle, so the cartographer chose the circle which cuts the prime meridian at 45°N., near Bordeaux, and the Equator at 90°E. and W.; if drawn it would form the horizontal mid line of this map. Beside true areas, this projection provides for all the major travel routes, polar and otherwise, and gives quite true conformal shapes except at the top and bottom of the map. There distortion arises because the regions remote from the tangent great circle are squeezed together by forshortening. It might be removed, at the cost of enlarging the distant areas, by the rectangular projection, or by arbitrarily or otherwise straightening out the southern tips of Africa and America, or perhaps best by combining such action with Miller's or with Gall's stereographic projection. By this last variation of the cylinder projections our screen

[3] CLOSE, C. C.: A Doubly Equidistant Projection of the Sphere, *Geographical Journal*, vol. 83, pp. 144, 5 and between pp. 176 and 177 (Map).

[4] THORNTHWAITE, C. W.: The Cylindrical Equal-area Projection for a New Map of Eurasia and Africa, *University of California Publications in Geography*, vol. 2, no. 6, pp. 211-30.

would not be tangent to the chosen great circle, but inside it, cutting the surface of the earth at say 25° on each side, and hence giving little distortion for a belt of 45° on each side. This covers most of the important world. The half of Antarctica shown on the left can be omitted to save space and improve the proportions of the map.

An interesting world map, very good for showing great circle routes from an American center but poor for any other purpose, is represented by one centering in Chattanooga with all the world but North America widely separating into six narrow gores radiating thence.. (Used as a wall map in the Chattanooga, Tenn. public schools.)

Still another, and better known projection, the gnomonic,[5] will always be useful in air age studies, though it cannot be applied to areas larger than a continent or ocean, and introduces grave distortions when extended widely. On this projection any straight line plots a great circle course, an obvious utility, especially in the more detailed studies, and in actual navigation.

(EDITOR'S NOTE.—A quincuncial projection of the sphere, devised many years ago in the Coast and Geodetic Survey, has been revived recently for showing international air routes. The projection is described and illustrated on page 19 of this issue.)

[5] DEETZ, C. H. and ADAMS, O. S.: Elements of Map Projection, fifth edition, pp. 149-154, *U. S. Coast and Geodetic Survey.*

The "New" Cartography

"What seems to be a rather widespread belief that the airplane has revolutionized geography and cartography is probably the most glaring admission of ignorance about these subjects in vogue today.

"If the discovery of polar projections revolutionized geography, the trick was done before the start of the Christian Era, by Thales and Hipparchus. Those who believe that the last few years have brought revolutionary advances to cartography should be reminded that as an aid for finding the Northwest Passage, Sir Humphrey Gilbert used a polar projection in 1582, and that a San Francisco architect won a prize for a modified polar projection used for charting the course of an 'around the world' airplane race to the World's Fair in 1915. As a matter of fact, few atlases published during the last four centuries have failed to include maps on one or two polar projection grids.

"Much of the 'new' cartography is extremely crude and misleading. Publishers' claims are commonly refuted by the maps themselves. It is obvious, for example, that on a North Pole-centered map, the great circle Equator has to look like a circle and so the shortest air route between two equatorial points will not be the straight-line chord between them. It is also true that the shortest line between Panama and Tokio, or Detroit and Berlin, is straight only in case the projection is gnomonic, and it doesn't matter whether it is a polar gnomonic or not. Northern hemisphere polar projections confuse shortest lines in the southern hemisphere in an atrocious manner and distort shapes far worse than most of the projections they are supposed to displace during this 'air age.' Neither the airplane nor aerial photography has solved the cartographer's original dilemma, which is equivalent to squaring the circle, the possibility of a perfect map."—Richard Joel Russell in "Post-War Geography," *The Journal of Geography*, November 1945.

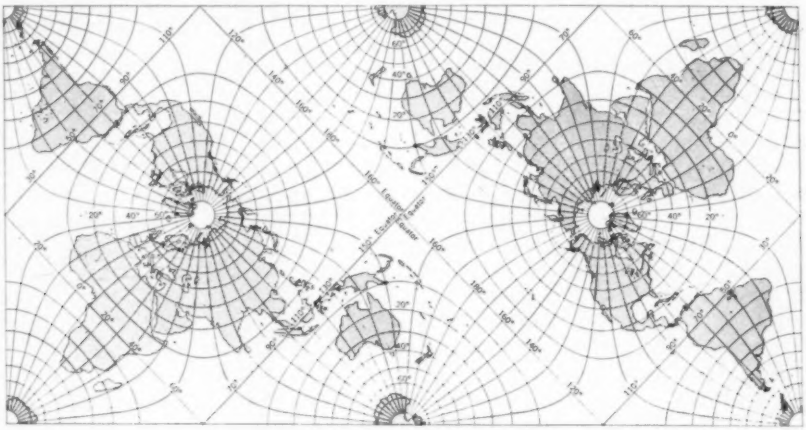
A Quincuncial Projection of the World

By ALBERT A. STANLEY

CHIEF, GEOGRAPHIC SECTION, U. S. COAST AND GEODETIC SURVEY

THE U. S. Coast and Geodetic Survey recently published Chart No. 3092, showing major International Air Routes on a chart constructed on a Quincuncial Projection of the sphere. The new chart is printed in three colors, including a buff tint for land areas, and the aeronautical overprint in red, with the projection and basic detail shown conventionally in black, on paper size 25 by 46 inches.

The quincuncial projection is formed by transforming the stereographic projection, with a pole at infinity, by means of an elliptic function. The resulting configuration of land areas is conformal, with the whole sphere being represented on repeating squares; also the major air routes, which for the most part follow approximate great circles, are in areas of least distortion, and in most cases are shown as straight lines. Angles of intersection are preserved exactly, and the maximum exaggeration of scale is less on the quincuncial projection than on either the Mercator or the stereographic projection.



A QUINCUNCIAL PROJECTION OF THE WORLD

The development of a quincuncial projection of the sphere was first presented in 1877 by C. S. Peirce, an Assistant in the Coast and Geodetic Survey, for the convenience it offered in meteorologic, geomagnetic, and other studies. Recent developments in world-wide aviation made it desirable to select a projection that would show the major air routes as approximate straight lines on a world outline preserving satisfactory shapes. For this reason the idea for projecting the sphere in the manner described was revived and introduced as a supplement to other recognized methods of portraying the sphere as a whole.

An added advantage in the use of a projection on which the whole sphere can be repeated in a transposed position is to provide peoples residing in either the Eastern or Western Hemispheres with a world pattern in accordance with their inherent geographical conception. A citizen of the United States using the map is able to observe the relationship of world land areas from his point of view as occupying a central geographical position; likewise a resident of Asia, by means of the repeated world image, is able to visualize the relationship of continents with Asia as the geographical center.

The Tetrahedron Prism as a Survey Target*

By LANSING G. SIMMONS†

THE Mapping Branch, Engineer Board, Fort Belvoir, Virginia, has been experimenting with tetrahedron prisms as light reflectors with the view of employing them as survey targets. These prisms, sometimes called triple mirrors, are orthogonal; i.e., three of the four faces are right triangles, the right-angled corners coming together at an apex. The fourth face, an equilateral triangle, is the one at which the source of light is directed.

This type of prism has the property of reflecting light directly back towards its source regardless of the angle at which the light strikes the surface of the reflecting face. Experience indicates that a good reflection can be obtained when the light strikes the surface at an angle as great as 60 degrees from the normal. Evidently a fixed prism would reflect light from sources as divergent as 120 degrees. Two prisms, properly faced, should take care of all lines of a normal triangulation scheme.

The purpose of the Engineer Board tests was to determine the practicability of using the prisms in place of signal lamps as targets for triangulation and traverse observations. The prism is placed over a station to be observed upon and a light directed towards it from the observer's position. The reflected light may then be used for pointings of the telescope. Tests were made principally to determine distances, at night and in daylight, at which the reflected light might be seen through a theodolite telescope. A 10-volt, 7.5 ampere bulb with a concentrated filament was used in the lamp which was also fitted with a 5-inch objective to concentrate the beam of light. Suitable reflections were obtained over a distance of 5 miles in daytime and 10 miles at night. Under ideal conditions, it is estimated that the night distance might be extended to 15 miles. Employing a heliotrope as a source, sufficient sunlight was reflected over a distance of 15 miles to obtain good observations.

In May 1945, a party of the Coast and Geodetic Survey, in an experiment with the prism, was able to obtain a reflection over a distance of only about 3 miles, using a standard signal lamp with a 6-volt, 1.25 ampere bulb. During June 1945, the writer, in charge of a special triangulation project for the U. S. Army at the Aberdeen Proving Grounds, tested the prism over lines of 3, 7½, and 11 miles in length. One of the new aluminum, open-framed signal lamps with a 5-inch reflector was used as a light source. A 6-volt, 1.25 ampere bulb was inserted in the lamp. A good reflection was obtained at 3 miles, easily visible to the naked eye. A definite reflection was seen through a 27-power telescope at 7½ miles. This reflection was rather dim, however, and as the atmosphere was clear it appears that 7 or 8 miles is near the limit for practical use of the prism with Coast and Geodetic Survey signal lamps. The attempt at 11 miles was unsuccessful although the atmosphere was somewhat hazy.

Personnel of the Engineer Board tested three sizes of prisms—2-, 2½-, and

* Published by permission of the War Department.

† Senior Geodetic Computer, U. S. Coast and Geodetic Survey.

3-inch diameter. The general conclusion is that the concentration of the beam of the light source is more important than the size of the prism in obtaining good reflections. The cost of the large prism is almost double that of the small one.

The whole idea is rather intriguing at first thought. To merely secure a small prism on a signal over a triangulation station and point it only in the general direction of the observer appears to be a simple substitute for a lightkeeper and a signal lamp. However, the very property of the prism that makes its use possible (reflecting light straight back to its source) works adversely to its employment in triangulation. It has been found that the source of light must be within about one foot of the line of sight of the telescope. To place several lamps so close to the various lines of sight at an observation station, while not an insurmountable problem, would be a rather awkward one. Moreover, the fact that the light beam must be narrow, in a small lamp, to obtain the needed intensity, requires that it be accurately directed toward the prism. This is not easy to do at night; in fact it is so difficult as to probably preclude the use of the prisms over triangulation lines of any considerable length.

Nevertheless it should not be concluded that the tetrahedron prism has no place in the field of surveying. It is quite possible that in triangulation of short lines such as in city surveys or special-purpose area work, the tetrahedron prism will have a practical field. Where a triangulation survey station is difficult to approach and is to be observed upon over many short lines, a good deal of time might be saved and much grief avoided by posting a prism or two at such station. This condition might very well occur in southwest Alaska. Personnel of the Mapping Branch, Engineer Board, are to be commended for bringing to light this fascinating device.

COMMENT

DR. ROGER S. ESTEY.*—The statement by Mr. Simmons is a very fair appraisal of the tetrahedron prism and its capabilities. Two or three additional comments might be of interest.

The range and observing convenience can be increased by the use of a theodolite and searchlight more closely coordinated in a common structure. The width of the returned beam can be increased by a slight change in the prism design and tolerating the moderate decrease in the returned beam intensity.

The prism is particularly useful when mounted in a position difficult of access or subject to movement such as a buoy, masthead, or weather balloon. It is a useful auxiliary at stations normally equipped with lights but not readily serviced in case of power failure. The prism is not bulky, does not require careful alignment, and is useful not only to establish a line of sight but for two-way blinker communication. It can be left mounted at a station of secondary imporportance for rechecking after the primary work is complete and the station crew has moved on. As a target placed against a background of other lights, it is readily identified.

While the tetrahedron prism is not expected to supplant existing surveying techniques and apparatus, it can very well serve as an adjunct which, in my opinion, will prove increasingly useful.

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* Bureau of Ordnance, Navy Department.

Radar in Peace*

By R. R. BROWN

PROFESSOR OF ELECTRICAL ENGINEERING, NORTH CAROLINA STATE COLLEGE

DURING the war, phenomenal advances were made in all fields of scientific knowledge, and in materials, methods, and uses. Much of this development has been kept secret for security reasons; much of the remainder was applied solely to war uses for victory reasons. But now that the war is over, the engineers are asking "What have we done?" and "What can we do with it now?"

For that is the way of the engineer; it is that characteristic of applying to practical use, for the benefit of all people, every new and useful material, method, or machine, that makes him an engineer in the first place. And it will be on his ability to make new applications, effectively and quickly, that will rest our greatest hope for a sound economic future, particularly in the years immediately ahead. And so it behooves us to examine carefully and immediately our wartime developments, that we may use them to the best advantage in the critical reconversion period now at hand.

Probably the best way to make such studies is first to ascertain what we have, how it was developed, how it works, and what are its present limitations. From that we can proceed to a study of future possibilities.

Radar a War Development

The subject of this paper is Radar—the most spectacular development of the war up to the advent of the atomic bomb, and generally recognized as the most important development in determining our victory, even including the bomb. Strictly speaking, radar is not a war invention, but a war development. The principle of radar, or at least that of range determination by means of radio echoes or reflections, was in use many years before the war in ionosphere measurements. In that use, a short burst of radio waves was radiated upward toward the ionosphere, or Kennelly-Heaviside layer, from which it was reflected back to the earth. A receiver detected the wave on its return, and from the time taken to travel up and back, the height of the reflecting layer could be determined. The results were used in determining best frequencies for long-distance radio communications, and also in weather studies and in other ways. The distance up to the ionosphere is considerable—40 to 50 miles—and the reflecting area is tremendous. Therefore, relatively long pulses could be used, and the reflected wave had considerable energy. Both factors tended to simplify the problem of measurement. As refinements were made in transmitters and receivers, double echoes and higher became common; the wave would continue to bounce up and down between the earth and the ionosphere—with decreasing amplitude, of course. And it became possible, with improved methods, to detect it up to the 10th, 15th, and higher "bounces."

A tremendous impetus was given to the research in this radio echo work by the war, particularly in England. The RAF was small, entirely inadequate to cope with large-scale bombing raids without early warning of the location of such raids. By combining directional antennas with the radio-echo devices, and im-

* Reprinted through the courtesy of the *North Carolina Engineer*, January 1946.

proving the sensitivity of the whole, the first real operational radar units were made. Their purpose was to detect and determine the range and direction of approaching bombers, early enough to enable the RAF to assemble their meager forces at a satisfactory interception point and also, of course, to give adequate warning to AA batteries, although no great advance warning was needed for those. From this purpose, RAdio Detection And Ranging, came the name Radar.

And it worked! It worked so well that a handful of RAF fighters were able to stop the powerful Luftwaffe cold. They made the raids so expensive in terms of bombers lost that the Germans practically stopped their bombings, which had been in daylight for the most part, and began to rebuild their forces and revamp their plans. In the meantime, the British had asked and begun to seek the answer to this: "What if they came at night? We can still see them with our radar and can direct our fighters to intercept, but the latter cannot see their targets. Why not a small radar for a fighter plane?" Just in time, such a radar was developed; just in time, because the Germans started their heavy night bombing attacks just then. The airborne radars were necessarily light, and had a very short range. But the fighter could be directed by radio from the ground to an interception point, and after interception could maintain contact and fire control with his radar. And again it worked! It worked so well that after that dramatic, climactic day in December 1940 when 287 German bombers were shot down over England in one 24-hour period, never again did the Luftwaffe regain control of the air, and Germany dropped her plans for an early invasion of England.

There were many difficulties with those early radars, the major of which probably was the inability to distinguish between friendly and enemy planes. This led to a considerable number of tragic losses, some of which continued to occur even after the adoption of a "zone" defense system, wherein each fighter was supposed to remain in his own individual zone. For satisfactory use of the radars, some identification method became imperative. It was developed as a small radar transmitter carried in the plane (and later, ship), which would answer the other radar in a manner similar to the reflection, but with a much stronger pulse; the answering pulses came to be coded for additional security. The Americans first called it RR (Radio-Recognition), but later adopted the British term IFF (Identification, Friend, or Foe). It was realized immediately that one of these "answering" units (called "transponders"), located at a fixed known position, would make an ideal radar beacon. For instance, if the operator of a plane's radar locates a transponder at Richmond, Va., as being 135 miles away at a bearing of 15° east of north, he immediately knows his own position. When transponders were so used, they became known as Racon units from RAdar beaCON.

Before I am accused of giving all of the credit for the development of radar to the British, let me say that from the very first, American electronics engineers were working side by side with the British engineers. No one man or group of men, or even one country, can claim all the credit for radar. It, like many of our other developments, was brought about by a pooling of knowledge, skill, energy, and determination.

Development of PPI and Loran

For our discussion, two other basic radar developments are worthy of brief notice; it is not worthwhile here to consider the multitudinous variations that were used. One was the development of the PPI (Plan Position Indicator), which made it possible for the radar to produce a complete map of all discernible echoes

in all directions simultaneously. None of our enemies had this unit until just before the end of the war. The other was the development of Loran (LOng RAnge Navigation), whereby a party could determine its position accurately by means of a receiver only, so that the position would not be disclosed by its own radar pulses. This was done by establishing two (or more) sets of transmitting antennas. Each set consisted of two antennas transmitting pulses, not simultaneously, but with an accurately known difference in time between the two. The receiver was designed to measure the difference in the time of reception of the two pulses whereby the difference in distances between the receiver and the two antennas could be found. With two different transmitting sets, and the proper charts or calculations, the location of the receiver could be found quickly.

What we have to work with now is pure radar, IFF or Racon, and Loran. The engineer will ask first for details of range, accuracy, power, frequency, cost, etc. Not much has been released on those details and I can only repeat what I have seen published. Ten-centimeter (3,000 megacycles) units have been shown; that much higher frequencies are possible is indicated by a statement in the ARRL Handbook that oscillators capable of 200 watts output at 0.2 centimeter wave lengths (150,000 megacycles) have been produced. In the October *Electronics* magazine, pulse powers up to 75 kilowatts are shown. Maximum ranges are startling, and are being increased constantly. That there is no practical limit to the range of a racon unit may be inferred from an experiment of years back, when the General Electric Company pulsed their radio station WGY, and picked up their own pulse after a complete passage around the world.

Pulse lengths as low as a fraction of a microsecond have been used. Range accuracies of about 20 yards in 20,000, and direction accuracies of a few hundredths of a degree have been indicated. Still more may be inferred from the fact that radar has been used for fire-control, for automatic tracking of fire control systems, for bomb sights, for GCA (ground control of approach, wherein a radar on the ground directs the landing of a plane through radio instructions to the pilot), and for radar control of rocket projectiles.

Costs have been high, and in high-power units may be prohibitive. However, in peacetime applications, there will be one tremendous advantage over war uses; our targets not only will be averse to being found—they usually will be anxious to co-operate. What this means can be seen by considering a normal radar search unit seeking to detect a distant aircraft. The transmitter radiates a powerful wave, beamed as sharply as feasible toward the plane, but even so the energy spreads so that only an exceedingly small amount of the radiated energy strikes the plane. Of that small amount, most will be reflected in the wrong directions, a very small percentage of it being reflected in the general direction of the transmitter. Then that part spreads again, so that only a fantastically small part of the original energy ever gets back to the receiver. But now suppose that the plane is equipped with an IFF system, or a modification of it. If the power this unit radiates were no larger than the original reflected wave, it still could be received as well as the echo. But that reflected power is a very small part of a watt; therefore, even a very low power "transponder" can return replies many times stronger than reflection signals. Also, since its receiver conceivably might be as sensitive as that used on the radar unit, it could reply to a very weak signal; hence the transmitter need not be large. It is to be expected that transmitters of a few watts peak output and receivers with only moderate

sensitivity will be used; the range still will be high compared to radar ranges. Another advantage in peacetime applications is that only comparatively short-range units will be required in nearly all applications where direct-echo radars are required. For example, a plane or ship navigating in fog will need to "see" only relatively nearby objects; long-range navigation can be done by racon or loran or other means. The importance of this comes from the fact that since both transmitted energy density and reflected energy density vary inversely with the square of the distance, the energy requirements of a radar pulse vary as the fourth power of the range; sixteen times as much energy is required if the range is to be doubled. Conversely, if the maximum range is reduced from say 20,000 yards to 5,000 yards, only 1/256th or less than four-tenths of one percent as much peak power is required, other things being equal.

Prospective Uses

With this information as a basis, a study of prospective uses may be undertaken. Certain specific suggestions are listed below.

1. *Sea Navigation*

Sea navigation is listed first, because it is already an established use of radar. It is to be expected that long-range navigation will be done by means of racon or loran units, although the present DF (Direction "Fixes" or finding) by radio will continue for some considerable time. All lighthouses most likely will be equipped with the racon units to increase their effectiveness when visibility is low or negligible (these units will supplement the lights, not displace them).

Seaports of considerable importance most likely will install shore radars to track all traffic. These may well be used in conjunction with radio to direct the approach of such ships as do not have radar aboard, and perhaps those with radar as well. Combined with television, a large-scale radar map of the port area could be transmitted from the shore radar to ship, the ship thus requiring only a television receiver, although some means of identifying itself would still be desirable.

All ships, except the smaller ones, may well be equipped with transponders. Some advantages would be (*a*) greater ease in tracking, (*b*) greater safety from collision, (*c*) emergency use, wherein the transponder could reply to all signals with a code indicating an emergency, perhaps even its nature. Consider the advantage of this last use alone. A rescue ship could keep in constant touch with the one requiring help, knowing its exact location at all times, day or night, while coming to the rescue. It is expected that all major passenger ships soon will be equipped with such units and with short-range radars.

2. *Air Navigation*

Air navigation also is an established use of radar, but here again we may expect many modifications. Airborne equipment for commercial planes likely will include racon navigation equipment, transponders (for about the same reasons as indicated for ships), short-range radar units to forestall collision and perhaps facilitate emergency landings, and some form of absolute altimeter, probably separate from the radar unit. All planes may be expected to have two-way radio before very long.

All of the major airports likely will have GCA systems. Not only can all planes equipped with a simple radio receiver be landed safely with this system, but it is safer and more accurate than the airborne radar system in most cases. The proper glide path and speed of approach are governed by local terrain, wind-type of plane, and its loading. The ground personnel may have charts correlated with their radar in such a way as to include all these factors, and they may inform the pilot of the slightest deviation from the best approach. Or automatic control devices in the plane may correct for any deviation; engineers who have witnessed this method have termed it "as accurate as sliding down a wire."

3. *Mapping and Contour Work*

Because of its high-range accuracy, radar should find considerable application in making plan and contour maps from the air. In this use it most likely will be combined with optical methods, partly because of their greater direction accuracy, and partly because of their greater intelligibility. For contour work, modifications in the indicator method will be desirable so that the scope will show two directions and distance, but this is a relatively simple change.

4. *Weather Mapping*

Radar has already been used to some extent in meteorology, both in tracking "weather balloons" and in tracking storm clouds. Weather observations obtained by tracking free balloons by radar will not depend on visibility. By using automatic-tracking units, with some minor modifications, full information regarding height, direction, rate of rise, wind direction and velocity, etc., may be plotted automatically in any weather.

Life magazine recently carried a series of radar pictures showing the approach of the Florida storm. It has been suggested that the atomic bomb could be used to disrupt such a storm; it will certainly be worth trying. A radar-controlled rocket could be directed to the center of the storm and exploded; if it blew out the "eye" of the storm before it reached the coast, thus preventing millions of dollars in damage, we finally would have "done something" about the weather!

5. *Land Transportation*

Newspaper articles we have been reading recently have discounted strongly any likelihood of radar being adapted to any form of land transportation in the now-discernible future, the reason given being that the desired echo would be obscured by the multiplicity of stray echoes. Insofar as direct-echo radar is concerned, that is probably true, but if the desired "target" is equipped with a transponder, its reply will be so strong that the receiver gain could be set so low that ordinary reflections would not be discernible. It should be quite possible, for instance, for the engine-man on a train to keep track of other trains over a range of several miles with a relatively small inexpensive radar. Such applications probably will be made first between sections of crack passenger trains. The transponders could be coded to show at a glance whether the train ahead was moving or stopped or even to indicate its speed; if no response were received, the operator would know at once that something was wrong.

Application to other land transportation systems may be expected to be much slower in coming.

6. *Surveying*

Rough surveying, especially over rough terrain, offers an interesting field for radar. Several oil company engineers have expressed a keen desire to use radar in their soil surveys, believing that it may save them many thousands of dollars each year. Radar accuracy is entirely adequate, according to their statements. In this work, the difficulty of locating the desired target may be overcome by the use of special reflectors which will reflect an especially strong signal, or by small transponders. The reflectors could be tuned parasitic antennas, with strong directional qualities, or flat metallic surfaces or corner reflectors. The corner reflector has the shape of the corner of a rectangular box, and acts like the corner of a box or room lined with mirrors. The reflected light (or radio wave) will be reflected directly back to the point from which it originates, while reflections from other objects will be scattered.

7. *Remote Signalling, Meter Reading, Switch Indications*

Modified transponders can be very useful in this type of work. Their replies can be made to contain almost any kind of information. For example, the Raleigh Water Department could have a small transponder located at each of its reservoirs or tanks. By pressing a button at the plant, the operator could secure instant information on water level, rate of flow, etc., from each point. (This is cited merely as an illustration, because, in this case, there are probably better and more economical methods available.) Where the distances are great, or where other means are less applicable, radar could be useful. A power system operator could keep track of all parts of his system, and trace faults immediately by means of small transponders at all important switch or fuse positions. A railroad dispatcher could maintain a complete map of all trains in his district, all major switch positions, and would have immediate knowledge of any faulty operation. A transmission line operator could locate faults on the line by reflections set up at the point of the fault, although simple d.c. pulses will be more satisfactory than radio pulses for wire systems. There are innumerable possibilities in such applications.

8. *Rocket Research and Control*

Work is going ahead all the time on rocket propulsion. In the research work, information on speeds, acceleration, and flight are necessary. Radar furnished the best means of securing such information. With some modifications, direct readings of position, speed, and acceleration may be plotted automatically and practically instantaneously.

For remote control of these or other units, accurate information on their position is imperative; that calls for radar control. Methods already at hand make radar control quite simple; automatic radar control will not be much more difficult. Automatic control from a radar unit installed in the projectile (or plane) imposes no very grave difficulties; coupled with our present knowledge of automatic control devices, such applications are quite feasible, especially if the demands on the control are not too strenuous. Some one has suggested automatically controlled rocket projectiles to chase and destroy enemy aircraft; rather complex control problems might be faced if the enemy craft were taking evasive action ("dodging," in simpler words), but there is no reason such problems cannot be solved.

Such bits of information as have been published indicate the maximum speed of the German V–2 rocket was phenomenal—perhaps between 3,000 and 4,000 miles per hour. Even if that be exaggerated, such speeds can be expected in the future. And so perhaps we may look forward to mail or express deliveries from say New York to San Francisco, London, or Paris in about one-hour flights—and that would be "fast mail." Radar control of approach seems the only plan by which it could be successful.

Television and FM

Two other fields in which radar principles will serve may be mentioned, although they may be related to radar only through pulse characteristics. The first of these is television. Because television signals are also high frequency radio waves with pulse characteristics, they will have to be handled by receivers very similar to the radar receiver, and also other television circuits have close counterparts in radar. The research in radar has solved most of the television problems, so far as circuits, tubes, and indicator (either screen or projection) tubes go. We may expect, therefore, a tremendous impetus to be given to television in the near future.

The second has to do with high-frequency transmission in broadcast work, whether television or FM. Both require very high frequencies, and transmission approaches a line-of-sight limitation; so antennas at great heights are indicated. Most communities will be faced with a shortage of suitable antenna sites. A method has been devised whereby many programs (say 10 to 15) can be broadcast from the same antenna, on the same base frequency, at the same time (essentially), with the receiver being able to select the program desired. The system is called Pulse-Time Modulation, and consists of breaking up each program into a series of *very* short pulses, the pulse repetition rate being different for each program, but supersonic in all cases. The receivers are made responsive to the pulse repetition rate so that the desired program may be selected.

There has been considerable publicity on experiments to be undertaken to determine the feasibility and economy of using relay stations in planes at altitudes of 30,000 feet and up for broadcasting FM and television programs. It is quite possible that pulse-time-modulation may be applicable there also, so that several programs may be broadcast from the same plane.

Sonar

Sonar (SOund Navigation And Ranging), the under-water counterpart of radar, properly enters this discussion, not only because of its relationship to radar, but because there is an overlapping of the two fields of application. For instance, sonar was used in an absolute altimeter for planes before the war. Sonar uses the echo method, but with sound waves instead of radio waves; the frequency is usually supersonic, say 20,000 cycles per second or higher. The speed of the sound waves is relatively very slow, being roughly 1,000 feet per second in air, 4,000 feet per second in water. Therefore, the speed in air of a radar wave is nearly one million times as great as that of a sound wave, or conversely, the time of travel of the sound wave is nearly one million times as great as that of the radar wave.

For short ranges, this longer time-of-flight has three advantages: first, the longer time may be measured more accurately; second, the pulse does not have to

be so short in time, and third, the frequency does not have to be so exceedingly high.

Accordingly, we may expect sonar to be used in place of radar in a considerable number of short-range applications; for instance, it now seems a more likely method than radar in many land transportation uses.

Costs

It is pretty hard just now to predict what the costs of radar units will be, but a wide range may be expected. The more expensive units have run into many thousands, even many tens of thousands of dollars, in wartime fire-control radars, for instance. However, the development costs largely have been paid, and the vast majority of peacetime units will be low-powered units. There seems no reason why small units suitable for navigation may not become but little more expensive than a good television receiver, a few hundred dollars at the most. Transponder units should become little, if any, more expensive than a good radio receiver. For those installations using GCA and television transmission, a television receiver will be adequate in many cases. It does not seem likely that any of the applications suggested here will be held up for any material length of time purely on economic grounds.

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Articles on Electronics Solicited

The question of what practical use may be made of radar-electronics in surveying and mapping activities obviously is of great interest to surveying and mapping people. It may well be that radar methods will introduce revolutionary techniques in certain types of distance measurements, in horizontal-control surveys for mapping projects, in ascertaining coordinates of the airplane at instant of camera exposure, etc. Accordingly, the American Congress on Surveying and Mapping cordially invites all those who have had experience in or have been associated with radar-electronics to submit their views or questions for publication in this Journal. Especially desired are brief, non-technical articles covering such topics as: results of demonstrations and trials; expected uses; requirements for new radar devices; and similar subjects. The pages of this Journal are available for a full discussion of the subject. Articles or inquiries may be sent either to the Editor or to the Publications Committee.

GEORGE D. WHITMORE
Chairman, Publications Committee

Tacheometric Reduction and Calculation of Coordinates for Traverses

By CAPT. N. B. FAVELL

EDITOR'S NOTE.—The author's terminology and arrangement of the following article have been retained without alteration. The term "tacheometer" which is now rarely used in this country may, for the purpose of this article, be considered as any instrument having a vertical arc and telescope with stadia reticule. It should be noted that the very great majority of telescopic alidades and perhaps half of the transits manufactured in this country are now equipped with vertical arcs containing an index for the ready reduction of inclined distance readings to the horizontal. However, those surveyors having occasion to use stadia measurements, and who are not equipped with the Beaman or other horizontal reduction index, will find Captain Favell's article of special interest.

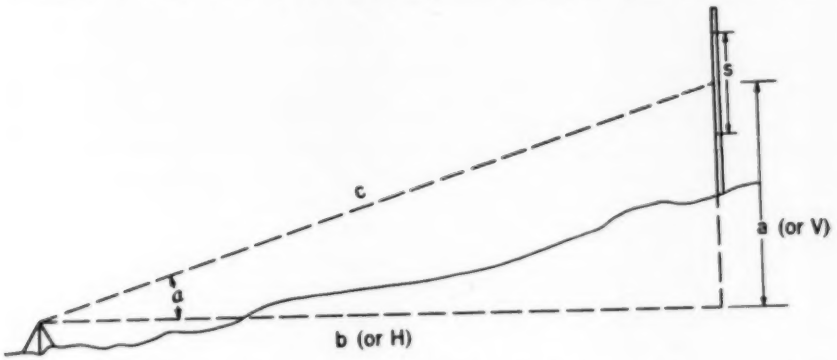
It is presumed that a modern tacheometer, with anallactic lens or internal-focusing telescope, is used so that if

s = the staff intercept,
D (the unreduced tacheometric distance) = $100s$.

Let $$F(\alpha) = \frac{\alpha}{\sin \alpha}$$

and $$T(\alpha) = \frac{\alpha}{\tan \alpha}.$$

Where α is the value of an angle expressed in degrees and decimals of a



degree; by equating the relations in the right triangle shown in the accompanying figure, we get the expression

$$\frac{\alpha}{a(\text{or } V)} = \frac{T(\alpha)}{b(\text{or } H)} = \frac{F(\alpha)}{c} = \frac{F(2\alpha)}{D}, \qquad (1)$$

the equation applying both to the solution of a right triangle with sides a and b, and hypotenuse c, and to the solution for tacheometrical reductions where

The formulas of this article are used with permission of the Empire Survey Review, in which they first appeared.

s = the staff intercept.
D (the unreduced tacheometrical distance) = $100s$.
α is the vertical angle observed when taking the staff intercept.
V is the difference of level between the telescope axis and the intercept on the staff of the middle hair.
H is the reduced horizontal distance.

Taking the two solutions separately:

(*a*) For the right triangle,

$$\frac{a}{a} = \frac{T(\alpha)}{b} = \frac{F(\alpha)}{c},$$

where c is the hypotenuse and α is the smallest angle of the triangle.

(*b*) For the tacheometric reduction,

$$\frac{a}{V} = \frac{T(\alpha)}{H} = \frac{F(2\alpha)}{D}.$$

These equations are proved as follows:

(a) $$a = b \tan \alpha = c \sin \alpha$$

whence $$a = \frac{b(\alpha)}{T(\alpha)} = \frac{c(\alpha)}{F(\alpha)}$$

and

$$\frac{a}{a} = \frac{b}{T(\alpha)} = \frac{c}{F(\alpha)}.$$

(b) $$\frac{a}{V} = \frac{\alpha}{D \sin \alpha \cos \alpha}$$

whence substituting $\tan \alpha \cos \alpha$ for $\sin \alpha$

$$\frac{a}{V} = \frac{\alpha}{D \tan \alpha \cos^2 \alpha} = \frac{\alpha}{\tan \alpha} \times \frac{1}{D \cos^2 \alpha} = \frac{T(\alpha)}{H}.$$

Also,

$$\frac{a}{V} = \frac{\alpha}{D \sin \alpha \cos \alpha} = \frac{\alpha}{D \frac{1}{2} \sin 2\alpha} = \frac{2\alpha}{D \sin 2\alpha} = \frac{F(2\alpha)}{D}.$$

Thus, if we have an ordinary type of slide rule with the addition on the slide of a scale showing degrees and decimals of a degree opposite the corresponding values on the C scale of $\frac{\alpha}{\sin \alpha}$ and $\frac{\alpha}{\tan \alpha}$, we obtain a rapid method of solving a right triangle, and getting our traverse coordinates by setting out the first three proportions in equation (1) on the C and D scales. A slide rule of this type exists as the P.I.C. Differential Slide Rule.

If the twenty-inch rule is used an accuracy of 0.2 feet may be expected, which is more than sufficient for tacheometric traverses.

If we wish to use the slide rule for our tacheometric reduction we must use an angle reading on the $F(\alpha)$ scale twice that of our observed vertical angle. This gives a method of reduction quicker than any other, and could be still further improved if an $F(2\alpha)$ scale were incorporated on the slide rule.

The writer is unable to trace the address of the makers of this slide rule, which is designed under British Patent 411090. It is possible that it is no longer obtainable under war conditions, but it used to be procurable through any British firm dealing in surveying and drawing instruments.

A Bid for the Tiny Angles*

By THOMAS E. RILEY
FIRST LIEUTENANT, CORPS OF ENGINEERS

TRAVERSES in the jungle are a tough proposition, as any surveyor in the Asiatic-Pacific theater will agree. In the mountains of northern California and at one advance base in the Netherlands East Indies an answer to the problem of the control traverses over rough terrain was found in the subtense bar traverse.

This system has found much favor in Europe but has not been used to any extent in the United States. The United States Army, however, has supplied many of its topographic and survey units with the equipment, though, here again, it has not been used to any extent. Simply, the method is to read the horizontal angle between the two ends of a bar of known length at an unknown distance away. The distance is then computed or looked up in a compiled table.

The subtense bars used were built by Wild of Switzerland to function with the Wild T2 theodolite which was also available. The theodolite is directional, reading to one second both vertically and horizontally. A Wild subtense bar (fig. 1) consists of a horizontal bar of invar steel, mounted on a tripod identical

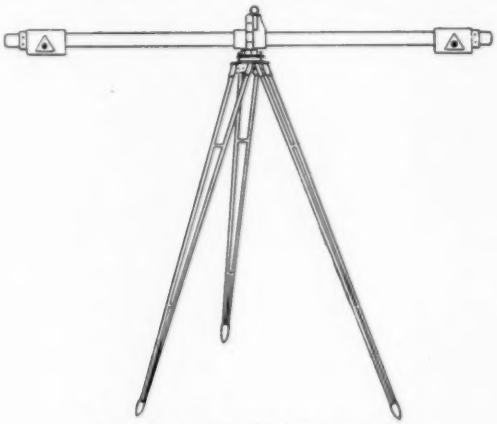


FIGURE 1.—A Wild Subtense Bar.

to the tripod of the observing theodolite. The bar has targets mounted on each end, exactly 2 meters apart. It is equipped with lighting facilities, universal bubble, an accessory plumb bob, and a sighting device to set the bar perpendicular to the line of sight. The targets are black and rectangular, 7.4 cm by 5.2 cm, with a superimposed white equilateral triangle (5.5 cm sides). The principle involved is: if the angle subtended by the two targets A and A' (fig. 2) is observed from point O and the distances AP and $A'P$ are known and perpendicular to the line OP, the distance OP can be calculated (co-tangent of angle AOP).

The accuracy of the method depends on the quality of observations, on the distance between targets of the bar, and on the length of sight. It was found

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that one set of direction angles, the 2-meter bar, and distances to 600 feet in the day-time and 1,000 feet at night resulted in an accuracy of 1 : 5,000, or third-order traverse.

Operating Procedure

The operating procedure in starting a subtense traverse is to set the theodolite on a tripod over the initial traverse station, and to set up one of two bars on another tripod anywhere in the direction to be traversed (not necessarily over a stake or point). As the tripods will not be moved until the observing is completed through them, no point setting on the ground is necessary. The tribrach plate on the tripod head is the point. The angle from the occupied station's backsight to the left target of the bar (the foresight) is read clockwise and recorded. The instrument is next pointed on the right target of the bar as viewed

Figure 2.—Principle of Subtense Bar.

by the observer and this angle is recorded. As the instrument is a direction theodolite, this second angle will be the sum of the first angle read and the angle between the two targets of the bar. The telescope of the instrument is reversed and the angles reread counterclockwise from the right target back through the left target and closing on the initial backsight. From this set of observations we have the azimuth of the first tangent of the new traverse by the mean of the backsights and the mean of the foresights, and we have the distance to the first station by the subtense tables.

The theodolite is then carried forward, leaving the tripod undisturbed. The second bar is placed on this tripod and the theodolite replaces the foresight bar. The foresight bar is carried forward to a new position and is placed on the third tripod. Angles are then read clockwise from the left target of the backsight bar, to the right target of this bar, to the left target of the foresight bar, and to the right target of the foresight bar. The telescope is reversed and the angles reread counterclockwise as before. From this set of observations we have a second measurement of the first tangent, a measurement of the second tangent, and the azimuth of the second tangent. From here the operation is repeated until the traverse is finished, giving two measurements of each tangent or leg of the line.

The traverse party consists of four men: two barmen, one recorder, and the instrumentman. In civilian practice especially, this small party would be an advantage. Another point is that stakes or monuments are set only where they are needed for control positions. This was a blessing in the hard coral rock where only iron drift pins could be driven.

In swamps some point to set the tripod can nearly always be found and the measurements then are read over ground impossible to chain. Mountains, deep ravines, and streams mean nothing to this method and rapid progress over rough terrain can be made. Though it is not commonly known, a distinct advantage is the fact that there is no slope correction in the system. Measurements on slopes up to 61 degrees (the limit of observation of the theodolite without special equipment) can be taken with no lessening of accuracy. The advantage is due

to the fact that horizontal angles are read to derive the distance. This can be best explained by picturing two imaginary lines perpendicular to the earth's surface through the targets of a subtense bar. Reading the angle between the lines at a level with the instrument gives the horizontal distance to the bar. Then to read the angle anywhere up or down the two lines at a higher or lower elevation, the telescope on the instrument will only be moved vertically and the angle on the horizontal plates will not change, giving the same horizontal distance as if read at a level with the instrument; therefore, no slope correction. Neither is there any need for stadia correction, because the bar is always at right angles to the theodolite.

Another great advantage is that the system can be run with ease at night. Both the theodolite and the bars are fitted with exceptionally good lighting systems and no extra men are required. Long sights up to 1,000 feet are obtainable and the pointings of the instrument are actually easier and more sharply defined than in the daytime. Angular closures have been better on the night surveys. The method should be of advantage to the field artillery because of this night use, if for no other reason.

Running Levels

Levels can be run with subtense traverses, taking no extra men and only a few additional seconds of observation on each setup. Trigonometric leveling is used and the procedure is simply to record the zenith angle of a target which is clamped to a fixed position on the center of each bar. As the theodolite reads directly to one second, the levels run have often approximated third order and have never fallen below $0.05 \sqrt{\text{Distance in miles}}$ or fourth order. Computing of the elevations is done in the office.

Computing of the distances can be simply done either in the field or in the office, for the maker furnishes tables that give the distances directly from the angle. Also, an azimuth closure is a check on the distance in this method as the distance angles and the azimuth angles are interrelated in the observing procedure. Something that has never been considered to full advantage is this positive check by the azimuth closure of a subtense line. Upon completing a traverse the azimuths should be totaled in the field, proving the line before leaving it. Also, when using the method at night an observation on Polaris or other star (quickly made with the Wild T2) can be taken on the traverse and the line proven in the field both in azimuth and distance by the azimuth closure to that point. Then, while the traverse is continuing, the line can be plotted up to the azimuth station by the office personnel. It seems this fact would also be of value to artillery or to other surveys where lines must be quickly plotted.

The traverse can be easily correlated with triangulation, for the same instrument and party can be used for both.

Summing up, the advantages of the system make it worth more attention than it has received, especially in terrain difficult for chaining. Computations are so simple that proving the line in the field before leaving it is practical. The small party involved and the excellent progress obtainable at night bring in an economic viewpoint that should be of interest to many.

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REMEMBER THE ANNUAL MEETING, JUNE 28–29, WASHINGTON, D. C.

Technical Education Plus the Humanities Makes a Better Engineer*

By DR. A. R. STEVENSON, JR.†

THE position which any profession holds in a community depends upon the sum total of the worth of the individual members in that profession. If, for instance, the engineers in any community are narrow-minded specialists, lacking an understanding of the basic human aspirations and convictions, the community will not seek counsel of those men, and will tend to discount whatever their profession represents.

Aware that many sections of the engineering profession were already gaining a reputation for narrow self-interest, a group of the older, well-known engineering societies some years ago formed the Engineers Council for Professional Development. This is a unified effort having educational objectives. The work of the E.C.P.D. is carried out under four main committees. A Selection and Guidance Committee endeavors to see that the right kind of young men go to engineering schools, and that the wrong kind do not; an Engineering Schools Committee contacts the colleges and accredits the courses; a Professional Training Committee stimulates post-collegiate education; and a Professional Recognition Committee is in specific charge of trying to raise the prestige of the engineering professions.

These committees were formed because it was held that the level of a profession can be raised only by improving the education of its members, and that the influence of a profession depends to some extent upon unified aims.

In the course of analyzing the place of engineers in society, it was found that there has been a regrettable tendency for these men to form numerous narrowly limited groups corresponding to equally circumscribed professional specializations. Clear evidence of this tendency can be found in a list of such groups which numbers well over three hundred.

Widen Horizons Through Post-Collegiate Study

About half a century ago there were only one or two kinds of engineering taught in the colleges. Today there are undergraduate courses in a host of engineering specialties. But the present tendency for young men to specialize in undergraduate work is a limiting educational experience. Such a statement is not made to depreciate the value of special study, but rather to point out that the various demands of living and working as an engineer are better met by the person who gains a general basic training and who then develops special interest in, say, electronics or refrigeration.

To be a fully successful engineer, a young man must have much more than a narrow technical education. A technical education has to do with *things*. Employees at the bottom of any organization deal with *things;* those at the top deal with *people*.

In the post-collegiate training which comes under my supervision, it fre-

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† Assistant to Vice President in Charge of Engineering Policy, General Electric Company.

quently happens that men who hold degrees in mechanical engineering develop pronounced capabilities in electrical engineering, or the reverse. We quite frankly say that we make electrical engineers out of mechanicals and mechanical engineers out of electricals. We forget almost immediately what a man's college degree is. In fact, one of our prominent mechanical engineers was graduated as a chemical engineer.

In addition to the extensive and varied courses given to engineers before the war, our company is planning to present, in the postwar period, some courses to increase the horizons of chemical engineers and metallurgists. The new courses will have very little of chemistry or metallurgy in them, and, instead, they will include widely varied engineering information designed to make these men more versatile and consequently eligible for reassignment and promotion. And, as an essential element, emphasis will be placed upon working smoothly with other people.

Leadership

One of the precepts used in our human relations classes is that in dealing with people it is not sufficient to be right, one must also persuade. This is of great importance, particularly to the young engineer whose education has largely dealt with *things*.

In 1923, Professor J. Duncan Spaeth, who was professor of English at Princeton, gave a talk entitled, "Law for Man and Law for Things." In this talk he pointed out that when an engineer has built a bridge, if he has built it properly, and in accord with the law of things, the law of gravity, and the law of stress and strain, he can go home and go to sleep. And when the rain descends and the floods rise and the ice breaks and the great floes come crashing down upon the buttresses of that bridge, he doesn't have to get up and talk to the bridge and reason with it, and argue and try to persuade it, and say, "For heaven's sake, bridge, be a 100 percent bridge. Stand by me now." It is as ineffectual to use emotional appeal on *things* as it is to use cold, bleak logic in seeking to persuade people.

Since this is an age of material influences and scientific analyses and techniques, it follows that a successful person must know how to approach problems scientifically and to discuss them with logic. But he cannot convince other people of the worth of his ideas, no matter how correct, unless he can also convey these ideas to others with warmth and human feeling.

In the period preceding this war there was a lack of leadership in this country and in the world. It was lack of business leadership which permitted the depression, and lack of government leadership which prevented normal recovery from this depression. The war was brought on by a failure of statesmanship.

It is obvious that military organizations require leaders. They make a profession of developing such men. It may be that emerging from this war will be leaders who have been developed by their military experience, and who will come back and apply their leadership ability in civilian life.

Dangers of Misdirection

We have not gone far enough, however, if engineers are taught only the art of persuasion. A leader who can persuade others to follow him is very dangerous unless his direction is both scientific and humane. Hitler is the classic example of misdirection.

An officer's guide for the U. S. Army, in an early edition published sometime before 1940, attributes to a distinguished military leader of a past era of the German Army the following classification of officers. According to this legend there are only four classes of officers. First, the brilliant and industrious. They make the best staff officers, for their talents provide maximum service to commanders. Second, the brilliant and lazy. Their tendency to avoid troublesome and time-consuming detail enables them to retain the perspective which is necessary in the art of making decisions. Their plans tend to the simple, the direct, the most promising for easy success. Third, the stupid and lazy. While this group will add little to military lustre, they can be used on small tasks which are necessary to be accomplished. At least, they will do no great harm. They can be retained and used. Fourth, the stupid (misdirected) and industrious. Great damage may result from their actions. Attacking the ill-advised with zeal and energy they may induce a disaster. They are the most dangerous. They must be eliminated.

In the exact sciences it is possible to prove rather conclusively whether something is true or false. In polities and economics, it is very much more difficult to be sure what is good and what is bad.

Pitfalls Avoidable

President Hutchins of the University of Chicago has pointed out that within the last twenty years some of our citizens returning from Italy came back with the idea that Mussolini was doing a very good job. The crime rate was low and the prosperity of Italy had been improved. He made the trains run on time. Based on short-time experience of something less than twenty years, one might have come to the erroneous conclusion that the principles of Mussolini's government were good and should be emulated. Today, we realize that Mussolini's regime was not based upon good principles, and it has brought horror and suffering to the Italian people. An analysis of historical developments, however, should have indicated that Mussolini's principles were wrong and doomed to failure without waiting for the conspicuous failure which has occurred.

It is certainly advisable that anyone who is going to help guide the affairs of the nation be a student of history. There is the old saying, "There is nothing new under the sun." Most government experiments have been tried again and again. If they failed in the past, they ought not to be repeated in the future unless there is some reason to believe that something different has been included which will overcome the first failure.

By way of analogy, when Professor Elihu Thomson and Dr. Steinmetz developed capacitor motors forty or fifty years ago, the motors were a failure because there were no good capacitors at that time. Within the last twenty years the capacitor motor has been revived and is now a great success because there are good capacitors in production. It would have been foolish to revive this type of motor if there had not been better capacitors than were available to Thomson and Steinmetz.

Thus, if engineers are going to participate in activities outside their technical fields and furnish leadership in the broader affairs of the nation, they must possess not only the ability to persuade but also the knowledge of the right direction in which to lead followers. These skills can be developed by studying and gaining experience in cultural subjects.

Broaden Technical Education with Cultural Subjects

There has been much discussion recently of how the engineering colleges are at the present time trying to "graft the humanities on to the technological stem of education." One may wonder what the humanities are. The humanities include a study of the cultural backgrounds of various peoples, the rise and decline of civilizations, and trends in social and individual human developments.

The man who wants to really understand human beings will be immeasurably helped by reading great literature. A book is a great piece of literature if it truly and clearly reflects human nature. A book is valueless in this respect if it is simply an exciting story intended to pass the time away and does not truly and clearly reflect real human qualities.

These remarks on the merits of a broad education may lead some graduate engineers to feel that having had a narrow technical education they can hope only to be specialists. Some people have the erroneous idea that youth is the time for all education. Shortly after the First World War, I heard a psychologist remark that tests on the soldiers showed that men reach the peak of intelligence at 24 years of age and go downward thereafter. His statement may be true for the large masses of people who cease studying at an early age, but it is both pessimistic and wrong to conclude that study in later life is fruitless. The mind is like a tool and if one stops making intelligent use of it, it will become dull and rusty. On the other hand, there are outstanding men whose minds are as keen as razors, mainly because they have kept them sharpened by strenuous use.

Probably most successful men feel that they have learned immensely more since graduation from college than they ever did in their undergraduate days. This is true in technical fields; and it is particularly true in the humanities. One can learn the exact sciences in colleges because they require no experience of life for their understanding; one can obtain an introduction to the humanities in college, but the humanities to be properly studied must be illuminated by experience of life.

Most older engineers will acknowledge that when they were in college they gave little thought to the humanities. They were absorbed in engineering and the exact sciences. This interest lasted for perhaps ten years out of college. Only a few men remain engrossed in highly technical things to their dying day, as did Dr. Steinmetz, for instance. On the contrary, most men gradually become more involved with people than with things. This shift in interest arises both because executive responsibility makes it necessary and because adult living broadens one's outlook.

It is probably true that most older engineers, ten or twenty years out of college, do not study science and mathematics in their leisure hours but are much attracted by history, literature, politics, and economics. The exact sciences are, of course, important, but the moment that the young engineer interests himself in the broader cultural subjects, he is more likely to get ahead. Of course one must know one's speciality, but to a great extent progress will depend on the other things which one knows also.

Make Security, Prestige, and Wealth By-Products of Vigorous Life

Many men gradually come to the conclusion that the most worthwhile things in life arise as by-products of responsible living. Most books on the history of

philosophy indicate that one cannot get happiness by making it the chief goal in life.

Unfortunately, in our society we all tend to put a money value on everything. Some may wonder, "How can I get rich by learning these cultural subjects?" They can be best answered with the persuasive prospect that they will be better, happier men, and more of a force for good in their communities if they will study and learn to contribute more to the community. As a by-product, they may get more power, prestige, and wealth.

The individual, or corporation, or industry that puts service first is more likely to be a success than one who is always saying, "What do I get out of this?"

Frequently, along with the results of inventive pursuit, useful by-products are developed which may prove, over a period of years, even more valuable than the accomplishment of the objective sought. In fact, great discoveries sometimes spring from apparently unrelated scientific developments.

A devitalizing element in our national thinking during the depression was our paralyzing fear of insecurity. Anyone who makes security his chief aim in life is almost sure to lose it. The man in the Bible who took his one talent and wrapped it in a napkin and buried it in the ground to keep it safe had it taken away from him. The man who took his five talents and adventured with them in the business world doubled his money. One of the hindrances to recovery from the depression was that those who had money tried to save it. If, as did one of our large railroads, more companies had borrowed money in order to electrify, the whole business world would have been healthier. The French built a Maginot Line, harboring the illusion that this alone would guarantee their security, and it may have been partly this false sense of security and its resulting complacency which made them an easy prey to the Germans.

It is the hope that engineers will not strive for security so assiduously that they fail to recognize opportunities available to them. Every practicing enginer should make as his habit the study of something each year of his life. Some of this study may be done informally at home, some in night schools run by colleges in some communities, and some may be done in classes run by the company in which the engineer is employed.

Engineering societies have made great strides in the past few years in establishing higher educational and professional standards for engineers. It is up to each person who is a member of the profession to educate himself to assume a role of responsibility to the group and to the community.

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A 5-YEAR ENGINEERING COURSE AT OHIO STATE

Five-year instead of four-year curricula in all degree-granting departments of the College of Engineering at Ohio State University, Columbus, became effective last fall. The plan adds more "cultural" or "broadening" courses. It calls for required 51 quarter-term hours of study in economics, political science, sociology, geography, psychology, history, etc. Students with superior academic averages at the end of their third year of the extended course may enter a special program which will lead to both master's and bachelor's degrees at the end of five years.

Elementary Concepts of Geodetic Surveys

By HERBERT E. HAYES*

IN A SYSTEM for survey and map control, involving an area large enough to necessitate a correction for the rotundity of the earth, mathematical principles embodied in the science of Geodesy must be used. Geodesy can then be defined as that science that treats of making the requisite measurements and reductions so as to locate relatively, with accuracy, points that are widely separated on the surface of the earth.

There are various reasons for geodetic control. The principal ones in which we are interested may be summarized under three general heads:

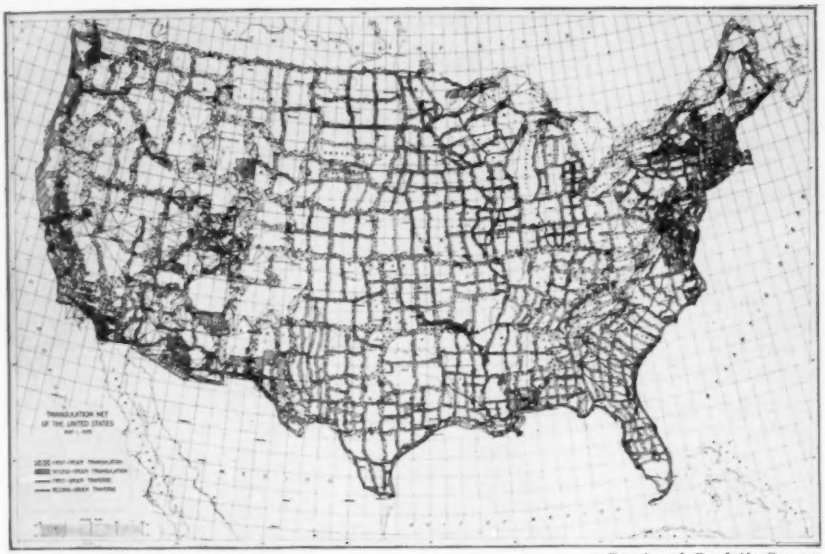
1. The location or recovery of monuments which serve as permanent controlling points in boundary or division lines.
2. The establishment of a net to control a survey or a layout of an engineering structure.
3. A control for a system of plane coordinates.

To carry out in a practical way such a task requires a knowledge of the figure of the earth, a knowledge of the various phenomena that might affect the measurements taken and a knowledge of the use and construction of the various instruments used in making these measurements, not to mention the accuracy of sight and touch so requisite for good observation and the ability to properly adjust the observational data so as to secure their most probable values.

In triangulation surveys the reconnaissance is of utmost importance. The base sites should be selected in order to secure good expansion and wherever possible a line of the precise net of the United States Coast and Geodetic Survey or a triangle side brought by precise triangulation from this net should be used as one of the bases, as it will furnish not only a controlling length for triangulation but also a geodetic latitude, longitude, and azimuth. A measured base line on the opposite side of the net from this control line will furnish a means for improving the accuracy of the lengths of the net. As to the triangulation stations, they must be intervisible and the proposed lines so far as possible free from horizontal refraction. These stations must be so placed that they will meet the purpose of the survey and provide well shaped figures for carrying the lengths ahead within the required degree of accuracy. The geometrical figures composing the net should be made up of completed quadrilaterals and central point figures, with all stations occupied.

Precise base line measurements are made with invar tapes. Invar is a nickel-steel alloy with a low coefficient of expansion (about 1/25 that of steel) and the tapes are, therefore, less affected by temperature conditions. At least two tapes should be used in the measurements and should be standardized both before and after the measurements are made and as near in time as possible without any intervening use of the tapes. The tapes must always be used on the base line in exactly the same manner in regard to tension and support as that

* Civil Engineer, Los Angeles Surveyor's and Engineer's Department.



Coast and Geodetic Survey

TRIANGULATION NET OF THE UNITED STATES, MAY 1, 1945

in which they are standardized. A base line should be measured in sections of 1 kilometer in length, except that there may be one section of shorter length. Each section should be measured at least twice with different tapes and in opposite directions. No more than two measurements are necessary unless the discrepancy between the forward and backward measurements of a section exceeds 10 millimeters per kilometer, in which case additional measurements should be made until agreement within this limit is obtained. Corrections are made for temperature and grade, and the measurements reduced to sea level.

On first-order triangulation the directions are ordinarily read by direction theodolites with graduated circles 8 to 9 inches in diameter. Readings to a second of arc are accomplished by the use of two or three micrometer microscopes. The mean of the readings constitutes one observation. One station is sighted on as the initial and readings are taken in a clockwise order on the other stations to be observed. The telescope is then reversed and readings are made on the same stations in the inverse order. Were all conditions perfect, a single careful observation of each direction would be sufficient. But the best instruments have defects, the personal equation of the observer enters into the picture and refraction plays a part that is at times baffling, to say the least. Sixteen pointings direct and sixteen reversed are made over each line and the average used to determine the direction to be used in computing the angles of the triangles. In order to eliminate errors due to irregular graduation of the horizontal circles, these successive initial observations are made on different parts of the circle by advancing the initial reading on the plate through a definite portion of the circumference after each set. In first-order triangulation an average closing error for all the triangles in a net should not exceed 1 second

with a maximum closure for a single triangle of 3 seconds. As a rule the results show that, with this standard for closure, an accuracy is obtained for the lengths far in excess of the required 1 part in 25,000, as set forth in the specifications for first-order triangulation by the United States Coast and Geodetic Survey. In recent years the observing has been done at night, the stations being made visible by electric lamps operated by dry cell batteries. All directions are reduced to sea level and it is apparent that the angle at a station subtending any two other stations is simply the difference between the two directions to these points.

Theory of Triangulation

The theory underlying triangulation is based upon the fact that if one side and the three angles of a triangle are known, the remaining sides can be computed by the law of sines. The measured field angles are spherical angles and they must be converted to plane angles for use in the plane triangles composing the length chain. This conversion is made by calculating the spherical excess for each triangle and then subtracting one-third of this spherical excess from each spherical angle of the triangle.

In carrying triangulation through a chain of figures from one fixed base to another fixed base the following discrepancies will develop:

1. The sum of the three observed angles of a triangle will rarely equal 180° plus the spherical excess for that triangle. These conditions for all the independent triangles composing the net are taken care of in what are known as the angle conditions.

2. In a quadrilateral the length of a side will have two different values when computed through two different sets of triangles. Although the triangles of the figure may close to 180° plus the spherical excess, the angles will still be inconsistent with regard to the closure of the whole figure when the lengths are computed. A similar condition can exist in a central point figure. These conditions in all of the independent quadrilaterals or central point figures are taken care of in the side conditions.

3. The measured length of the second base (or fixed line) will not agree with its length as computed from the first base through the strongest chain of triangles. This condition is taken care of in the length condition.

4. When the three kinds of discrepancies just mentioned are cared for by changes of the angles, and the latitudes, longitudes, and azimuths of the triangulation net are computed, starting with points fixed in position, discrepancies in latitude, longitude, and azimuth will be developed at the other fixed points to which the triangulation is connected. These conditions are taken care of in the azimuth, latitude, and longitude conditions.

Before the adjustment is begun, careful study should be made of the field data to see that the triangle closures are acceptable and that the side equation tests (or sine-to-side tests, as they are sometimes called) fall within the acceptable degree of accuracy. This is important as serious errors can be detected before going into the adjustment. The side tests show which particular direction is likely in error and additional field work can be made to clear up the difficulty.

The Least Squares Adjustment

There then exist these various conditions which have to be met and adjusted. In working them up care must be exercised that one equation is not identical with any other one. The proper equations, no more or no less, must be incorporated in the conditions to be satisfied; otherwise the triangulation computa-

tions after adjustment will not be consistent. After all these various independent condition equations are obtained, it is the function of the Least Squares adjustment to eliminate all of these discrepancies and secure the most probable values of the field data. The principle of Least Squares may be illustrated in this way. Assume that we measure some linear distance a number of times and each measurement has been made with the same degree of care and under the same condition as all the others. All of these measurements are therefore of equal weight and there is no reason for preferring any one measurement to any other. For this distance we may adopt a trial or tentative value and the difference between an observed value and this trial value is called the residual for that observation. The principle of Least Squares is based upon the fact that the most probable value for this distance is the one that makes the sum of the squares of these residuals the least possible—that is, a minimum. In this particular case the most probable value for this distance is the arithmetic mean. In a triangulation adjustment the condition equations are all taken and adjusted simultaneously, the corrections to the various directions or angles being made in such a way that the sums of the squares of these corrections (or residuals) is the least possible.

The results of an adjustment by the Least Squares method are sometimes misunderstood, especially in the placing of erroneous interpretations or unreasonable conclusions. The mistake of assuming that the results of an adjustment are absolutely correct must not be made. The results are, at best, only approximations to the true or correct values; the most probable and mutually consistent values for the given observations and the best obtainable. However, these results will satisfy the requirements of the adjustment within the uncertainties among the observations and can be safely used.

* * *

Seacoast Board Proposed in California

Advocates of the preservation and development of California beaches are proposing the formation of a state seacoast engineering board to examine any proposed shoreline developments before they are approved.

Claiming that littoral land requires constant observation, the report on a 2-year study recently compiled by a committee, of which Col. Charles T. Leeds, consulting seacoast engineer for the State Division of Lands, was chairman, advised against building of shoreline projects without expert advice.

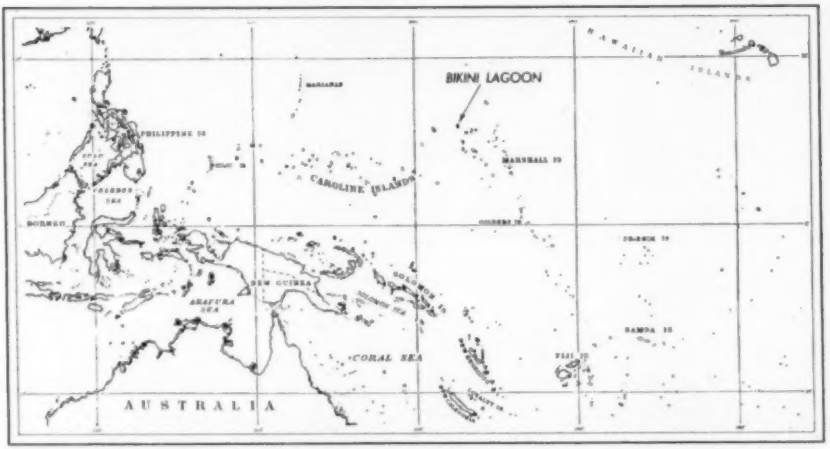
The State's Division of Lands authorizes structures built upon tidelands, but where these are transferred to a municipality, "the State cannot prevent one city from building an ocean structure that may so influence waves and current as to damage seriously other communities' shorelines," Dr. Robert Sproul, president of the University of California, said in presenting the report.—*Engineering News-Record*, January 31, 1946.

The Surveyor and Atomic Bomb Tests*

By A. O. QUINN†
LIEUTENANT, U. S. NAVAL RESERVE

SURVEYORS can take another hitch in their belts and relax with the knowledge that they are included in the Atomic Age—at least in the atomic bomb tests. Precise surveys are a necessary part in establishing the control to map the location of targets and various measuring instruments. Detailed hydrographic surveys are charting the floor of the Bikini Lagoon, and aerial photographs supplemented by later surveys will reveal the extent of damage suffered after the atomic bomb blast.

The atolls and single islands of the Marshall archipelago are formed exclusively of coral, built upward from submerged mountain peaks which at some time



BIKINI LAGOON IN THE PACIFIC—LOCALE FOR THE ATOM BOMB TESTS

in the geological past have risen close to the surface of the sea. No stone other than coral is found in the Marshalls except where it has been brought from elsewhere for building or other purposes, and there are no minerals except minor phosphate and guano deposits. Oceanographic and biological surveys are being made on a before-and-after basis to determine the effects of atomic energy.

Ground surveys based upon a triangulation net will be used to establish photo control. Numerous aerial and terrestrial camera installations will record the before, during, and after effects of the bomb. Since it is impossible to occupy triangulation stations at the time of the blast, and since the effects of tide, wind, drift, etc., will continually alter the location of target ships, it is planned to determine these positions from aerial photographs taken immediately before the

* Released for publication by Joint Task Force One.

† Lieut. Quinn is assistant to Director of Photography in connection with the Atom Bomb Test Project and will be assigned to the flagship of Commander, Joint Task Force One.

bomb drop. Ground cameras which will be protected by lead shielding are located at strategic positions, and computations from the photographs can be made to accurately determine wave and blast effects.

Seismic instruments located about the lagoon and in various places throughout the world will record land mass tremors.

Within the brilliant array of scientists who will gather an endless amount of technical data, the surveyor with photographs in hand stands as a link in the vital chain of gathering and analyzing scientific material. For without the knowledge of exactly where the data were found or recorded, the atomic bomb scientist proceeds in a maze of uncorrelated results. The experience of Army, Navy, Geological Survey, Coast and Geodetic Survey, and other technical institutions is combined to ensure the success of the atomic bomb tests.

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How They "Sank" the Cocos Islands

(Condensed from Sunday Mirror Magazine, New York)

One of the strangest stories to emerge from World War II reveals how the British "sank" the Cocos, or Keeling, Islands in the Indian Ocean, to save them from the Japanese. The 27 coral isles were the key relay point on the cable network linking Australia, the East Indies, China, and India. Capture of the Cocos group would have isolated whole sections of the Far East from direct cable connections with the outside world.

Military leaders in London decided something had to be done in a hurry. Already the Japanese were descending on the Philippines and there was no time to dispatch sufficient forces to hold the Cocos.

Then came an inspiration: "It's quite conceivable," volunteered one elderly officer, "that the Japs don't know about the Cocos. If not, we could literally 'blow' the islands off the map."

Other officers saw merit in the idea. Anything was worth trying. The Cocos were to be "sunk"—erased from every existing official map and record. Mention of the islands on the radio or in private conversation was tabooed. The Japanese Intelligence Service might thus overlook the islands.

In Australia thousands of new maps of the Indian Ocean were printed—with no trace of the Cocos. These decoy editions were hurriedly forwarded to all Far-Eastern British bases. Arrangements were made for the Japanese to capture a quantity of them.

The enemy eventually swept into the Christmas Islands, only 500 miles away. One night Japanese warships steamed past within firing distance and (as it turned out later) failed to realize that the blacked-out Cocos were even there.

After V–J Day, the Allies learned that Japanese commanders had thrown away their own maps of the Indian Ocean in favor of the captured "up-to-date" ones. Yet if the Japanese admirals had cared to walk down the street a few blocks from the Imperial headquarters and study maps they had on hand, the course of war in the Indian Ocean might have been much different.

Complete, accurate maps, showing the Cocos in full detail, were on file all the time in the Tokyo Library!—Peter Finley in *Magazine Digest,* February 1946.

Oregon Uses Lambert Conformal Conic Projection in Highway Surveys*

By C. B. McCULLOUGH† *and* H. G. SMITH‡

IT IS obviously impossible to project a curved surface on a plane, or accurately to represent such a surface on a plane map. Because of this fact, one of the problems that presented itself early in the history of mapping was the development of a projection which would achieve a compromise within the limits of accuracy desired. Several methods have been devised, each with some quality that renders it fit for a particular purpose.

The U. S. Coast and Geodetic Survey (U.S.C. and G.S.) has adopted two principal systems of projection to meet this need. For those states having their greatest dimension in a north and south direction, a system known as the "transverse Mercator" is used. For those states wherein the greatest dimension is in an east and west direction, which is the case with Oregon, a system known as the "Lambert conformal conic projection" has been employed as a basis for the resulting plane coordinate system. This method was developed some sixty years ago by a French physicist, Johann Heinrich Lambert, and it is in accordance with this projection that the battle maps of France and Germany have been prepared.

The Lambert conformal projection was first used in Oregon in the early part of 1934. At that time the U.S.C. and G.S. proceeded to develop the control data for projections in accordance with this system, and computed the Lambert grid coordinates for the numerous triangulation stations which had previously been established throughout the State.

In figure 1 the principal triangulation arcs for Oregon are indicated, together with the Lambert projection zones. It will be noted that that part of Oregon west of the 121° meridian, with the exception of one small parcel, has been traversed with first-order triangulation networks. Quadrangle maps of this area have also been prepared and published in final form. That part of the State east of the 121° meridian and north of latitude 44° has been mapped to the extent of approximately 50 percent, and control stations have been established in most of the rest of the region. That part of the State south of latitude 44° and east of the 121° meridian has hardly been touched. There is one control net that follows the Idaho-Oregon line throughout, and another that runs north from Lakeview to Wagontire and thence east to Burns; however, no other triangulation has so far been done in this area. In general, those parts of the State in which most of the highways are located and where the majority of the population lives, are covered by triangulation networks.

The Lambert conformal conic system consists essentially in the projection of the earth's surface on a developed secant cone. For the area to be mapped, two parallels of latitude are chosen for the traces of the secant plane. In general, these latitudes are spaced at a distance approximately equal to two-thirds of the width of the area to be covered by the maps. In other words, these standard

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† Assistant Chief Engineer, Oregon State Highway Department.

‡ Construction Engineer, Oregon State Highway Department.

parallels lie at a distance approximately one-sixth of the width of the area to be covered from the north and south lines of such area, respectively.

When the map is projected on this developed secant cone, it is obvious that the standard or base parallels will be true to scale. Along these parallels the map is accurate and true, but at all other points there is a certain amount of error. The maximum error occurs at a point halfway between the parallels and at the extreme edge of the fringes north and south of them. Error is not introduced by extending any map in a westerly or easterly direction, except such as pertains to azimuth. (The azimuth correction will be discussed later.) A single projection for the State of Oregon would permit a maximum error of one part in 5,000; this obviously should not be permitted in connection with field work, which

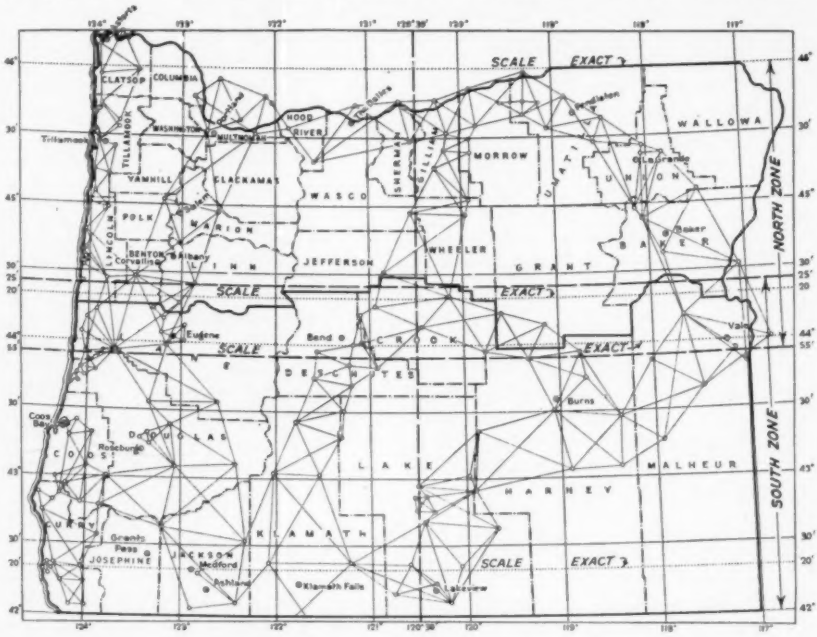


FIGURE 1.—Principal triangulation ares in Oregon shown in the Lambert projection zones.

has been held to a maximum error of one part in 10,000 and a probable error of one part in 30,000. For this reason, the State has been divided into two zones, which increases the accuracy to one part in 15,000.

The use of two zones, or secant cones, for the State obviously results in the establishment of two separate sets of coordinates which cannot be combined. In order to overcome this difficulty, the zones were made to overlap sufficiently to provide a belt extending over the central part of the State in which either the north or south coordinates could be employed. The southern boundary of the northern zone has been established at latitude 43° 40′, and the northern boundary of the southern zone at latitude 45° 00′, which affords an overlap of 1° 20′. For

the northern zone, the standard parallels are located at latitudes 44° 20′ and 46° 00′. For the southern zone, latitudes 42° 20′ and 44° 00′ are used. (See fig. 1.) The control meridian has been established at longitude 120° 30′ and for this point the x coordinate has been arbitrarily assumed at 2,000,000 feet. The use of this arbitrary value places the origin of coordinates out in the Pacific Ocean. However, its use results in giving all x coordinates in the State a plus sign; thus providing for simpler calculations and reducing the possibility of those errors which are apt to arise when coordinates are changed from plus to minus.

In regard to azimuths, it will be noted that the plane or grid azimuth is always referred to the central or controlling meridian and does not correspond with the geodetic or true azimuth except at this particular point. As the longitude is increased east or west of this controlling meridian, the grid azimuth will diverge from the true or geodetic azimuth by a small angle because of the convergence of the meridians, since all grid azimuths are parallel to the controlling meridian. For each minute of longitude, tables have been computed by the use of which grid azimuths can be converted into corresponding geodetic azimuths, or vice versa, with a minimum of computation.

Before adoption of the Lambert system in Oregon, surveys were made and azimuth corrected by observations on Polaris, or the sun, which many times entailed a laborious and time-wasting procedure. This necessitated the proportioning of meridian convergence throughout the line, so that a line which was actually tangent on the ground became curved with respect to its azimuth. This difficulty is eliminated by the use of the grid system, since there are no corrections to be applied. In other words, in reference to a system of rectangular coordinates, the azimuth for a straight line remains constant throughout its length.

All triangulation and most traverse stations established by the U.S.C. and G.S. in Oregon are equipped with what is known as "azimuth marks," which are short courses leading from the triangulation or traverse point to some local monument, the azimuth of which course has been predetermined. Local surveys may, therefore, be initiated by obtaining the grid azimuth for such an azimuth line, thus eliminating the necessity for an observation on the sun or Polaris.

More and More Surveys Tied in

For the first few years after the inauguration of the Lambert conformal projection system, surveys of the highway department were tied into the triangulation stations only where such a procedure was found convenient. During the past few years, however, an effort has been made to tie all surveys into the Lambert grid system and to make all computations conform to it. It has been somewhat difficult to tie all these surveys down, owing to the wide spread between triangulation points, to the inaccessibility of some of the points and, especially in western Oregon, to low visibility occasioned by fogs and haze.

As more of these surveys are tied into the Lambert system, a smaller network is achieved, and eventually it will be possible to tie highway surveys into the Lambert grid at any point with a minimum of effort. Although the type of triangulation done by the state highway survey parties has been rated as "third-order," its accuracy is in reality comparable with that of second-order standards.

Oregon's experience with the Lambert grid has conclusively demonstrated the fact that in actual practice it expedites both field and office work on location surveys. It also operates to eliminate any field errors, which under the old system

of location remained unknown until actual construction was commenced. As soon as any preliminary line is run and ties are made at both ends (and possibly at intermediate points), the closure of the traverse can be computed; and if such closure is not within allowable limits, an immediate check-up can be made before the error is carried on or continued into the located line. If and when such closure is found to be within allowable limits, the adjustment of the traverse may be computed and projections laid with mathematical precision. Ties between the preliminary and located lines, computed at frequent intervals, enable the field party to check on their work as they progress and thus to pick up and correct errors which might otherwise be continued for long distances and entail considerable retracing of the line. Such retracing, especially in timbered and mountainous country, can prove very expensive.

Because the preliminary and located lines can be accurately tied to each other, field parties are able to proceed at once with the tying in of section corners, property corners, and the like. They can also secure such other data as must be used on the located line without waiting for the office projection or for the field work of running in the located line on the ground. Such a procedure frequently permits full utilization of a field party, which otherwise would be idle or working at minimum efficiency during certain stages of the survey.

By means of the computation—and subsequent placement on the finished map—of the grid coordinates for all property corners, section corners, and so on, as well as the coordinates of all tangent intersections and other critical points along the highway alinement, it is obviously possible at any future date to reestablish such points with a minimum of effort. Further, this assures that any points replaced are in their exact original position.

Office work on location is greatly facilitated by use of the Lambert grid system. With the methods in use before this grid was adopted, it was frequently found that the preliminary line and the final located line could not be reconciled within a reasonable degree of accuracy. Then a new set of coordinates would have to be set up for the located line, and since these did not correlate with the preliminary coordinates, all field ties would have to be remade. The writing of right-of-way descriptions is also simplified by use of the Lambert grid.

For a short time after the Lambert system was first introduced in Oregon, the work of running primary traverse lines between U.S.C. and G.S. stations, as well as the work of computing the coordinates and grid azimuths, was carried on as a joint project between the State Highway Department and the Survey. A relatively small crew of men was employed for this purpose and only a small amount of funds appropriated for the work. With the exhaustion of these funds, work was closed down. However, the State Highway Department a little later re-established the project and continued the computation and clerical work necessary to keep the grid system up to date and in workable condition. During recent years this work has been carried forward, and as more and more field surveys have been tied into the Lambert grid, the State's records have become correspondingly more complete.

Information Dispensed to All Who Request it

At the present time the Highway Department serves more or less as a clearing house for information of this character, and disseminates it to various interested state, county, and governmental agencies. A rather complete file is main-

tained and information is dispensed to anyone who requests it. Several federal agencies, particularly the Army and the Bureau of Reclamation, have utilized the State's surveys in promoting and developing their own. In one instance, the North Unit Irrigation Project in Jefferson County, the Reclamation Service saved considerable time and effort by using various traverses and points established on the Lambert grid by the State Highway Department. During recent Army maneuvers in central Oregon, various parties of topographical engineers also made use of the data previously compiled by this department.

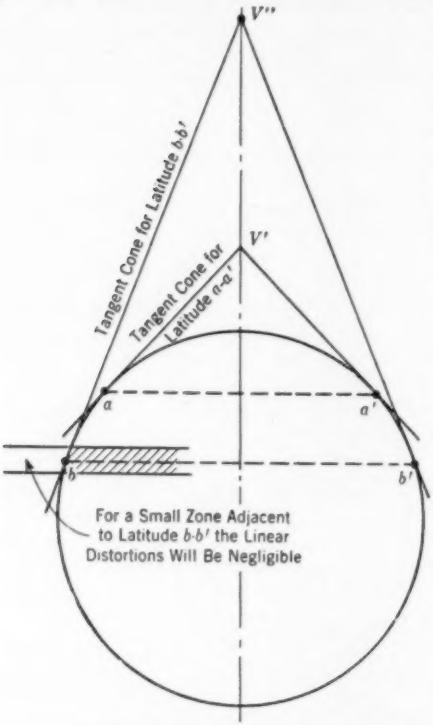


FIGURE 2.—Principle of Lambert system.

The ability to re-establish beyond dispute landmarks which have disappeared and property and section corners lost or destroyed will be of inestimable value to property owners in the future. Particularly is this true in certain logged-off areas of the State where scribed stakes used for section and property corners have rotted away, and bearing or reference trees have been destroyed.

Many section corners and other landmarks have been re-established since the State was first sectioned (about 1870), but in many cases permanent ties were not made. This has resulted in costly resurveys, and has been the basis of numerous lawsuits and property disputes. The use of the Lambert grid system will eliminate all this, since any point once tied in can be re-established with a minimum of effort.

In order to acquaint the State's locating engineers with the Lambert system, a circular letter was recently sent to them. The purpose of this was to explain the fundamental principles underlying the utilization of the system as applied to Oregon. Some of these observations have a general application and so are included here.

THEORY AND PROCEDURE SIMPLIFIED

As the circular explained, it appears that many of the State's locating engineers are reluctant to use this system in the belief that it is highly technical and involved and requires the employment of complicated mathematical derivations. This latter conception is erroneous, as the Lambert grid system is in reality based on some rather simple concepts.

Its application may be explained rather briefly as follows:

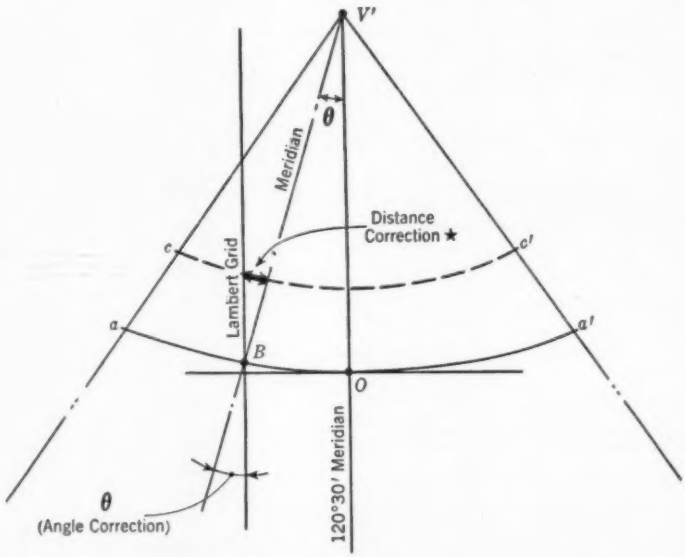
Since the surface of the earth is curved, no system of rectangular coordinates

drawn upon a plane can be used to represent distances and angles without introducing some error, since the only region over which the curved surface and the plane surface coincide is at the point of tangency of plane and spheroid. However, since the radius of the earth is comparativey large, the error introduced throughout any small region adjacent to this point of tangency would be comparatively small.

To develop the idea, consider figure 2 wherein the circle represents approximately a cross section of the earth. If at any point along a parallel of latitude, such as a-a', tangents are drawn in the various meridian planes, these tangent lines or elements intersect the polar axis of the earth at some point V to define a cone V'-a-a'. In a similar manner, tangents may be drawn from the extremes of any other parallel of latitude such as b-b' to define a second cone V''-b-b'. In any comparatively small region adjacent to these parallels, the surface of the earth and that of the corresponding cone are nearly coincident.

Lambert Grid Superimposed

Let us now develop the cone V'-a-a' as shown in figure 3, and with the point O



★ This Correction Is Shown in the Last Column of the Projection Tables, Opposite the Latitude of the Point in Question

Figure 3.—Developed cone superimposed on rectangular grid.

as origin, superimpose on this developed surface a system of rectangular coordinates, such as the Lambert grid. It is apparent that at point O there is no distortion either linear or angular. It is also apparent that along the parallel of latitude a–a', there will be no distortion in distances or linear measurements.

However, at any point east or west of the origin *O*, for example at point *B*, there will be an angular distortion, θ, since the geodetic or true meridians converge at the pole, whereas the Lambert grid lines are parallel. On any parallel of latitude north or south of the parallel of reference *a-a'* (for example *c-c'*), there will be not only an angular distortion correction, but a correction in distance (fig. 3).

These are the basic principles underlying the Lambert system; however, in order to secure even greater accuracy, the Lambert grid is referred not to a tangent plane, but rather to a secant plane, as indicated in figure 4, so that instead of one parallel of latitude (such as *a-a'*) along which there will be no linear distortion, two "standard parallels" are furnished within the limits of projection as determined by the "secant plane." The error in angle or in distance on the Lambert grid may be disregarded and the rectilinear coordinates may be used without appreciable error.

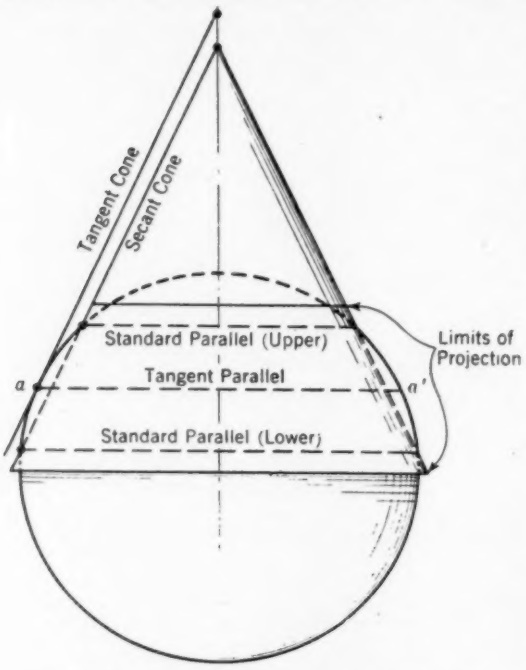


FIGURE 4.—Secant cone establishes limits of projection.

The system of Lambert coordinates has been devised to provide a tie between local plane coordinates and the more elaborate system of geodetic control which takes into account the curvature of the earth. The U.S.C. and G.S. has established a national system of triangulation which provides stations for nearly every locality and enables the local engineer to expand his surveys over greater distances and still provide correct azimuths throughout his traverse. By checking on other triangulation points in the vicinity, he automatically checks his traverse and thus avoids the necessity of closing it on the starting point.

Known triangulation points have been set by reliable organizations like the U. S. Coast and Geodetic Survey, the U. S. Geological Survey, the U. S. Corps of Engineers, the U. S. Forest Service, and the Oregon State Highway Commission. The points are a part of some network of triangulation and their latitudes and longitudes have been determined with considerable accuracy. The geodetic or true azimuths of lines radiating from any of these points have also been computed accurately so that the engineer can feel confident in using this information for his surveys.

In order to use the Lambert system, some triangulation point whose coordi-

nates are known must be tied into the survey. From that point on a traverse can be continued indefinitely and its coordinates computed by the usual method of latitudes and departures. Such a traverse will always remain on the Lambert projection. With suitable tables, the coordinates of any point on the traverse can be transformed into latitude and longitude, but this is of no particular value to the engineer. He can use the Lambert coordinates best.

For field use the latitude and longitude of any triangulation station which an engineer may use in his survey are transformed into plane coordinates on the Lambert grid; and these coordinates, as well as the azimuths of lines radiating from such point to other known points, are all determined and can be easily obtained from the State Highway Commission. Using these x and y coordinates as a starting point, and using the grid azimuth to some other point as a starting azimuth, the latitude and departure can be computed for each point on the traverse as the survey progresses. The latitudes increase toward the north and the departures increase toward the east.

Detailed instruction, tables, and other data are also given in the circular. They will be furnished on request to anyone interested in delving more deeply into this subject.

The derivation of the formulas for the solution of the constants used in this system of projection will also be found in Special Publications Nos. 47 and 52 of the U. S. Coast and Geodetic Survey. Further computations and applications will be found in Special Publications Nos. 67, 68, 71, 145, 193, and 194 of the same agency.

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VIRGINIA LEGISLATORS DON'T UNDERSTAND PLANE COORDINATE BILL BUT PASS IT JUST THE SAME

ONE PIECE OF LEGISLATION that admittedly has gone through the Virginia General Assembly with few, if any, members understanding its contents, was sent to the Governor, after final House approval. It is a bill that came through the General Laws Committee of both branches "without amendments"—since none could adequately explain its provision.

The measure is designed to describe and officially adopt a system of coordinates for designating and stating the position of points on the surface of the earth within Virginia.

Delegate C. G. Quesenbury was asked to explain the following language in the measure: "The Virginia coordinate system, north zone, is a Lambert conformal projection of the Clarke spheroid of 1866, having standard parallels at north latitudes 38 degrees, 2 minutes and 39 degrees, 12 minutes, along which parallels the scale shall be exact. The origin of coordinates is at the intersection of the meridian 78 degrees, 30 minutes west of Greenwich with the parallel 37 degrees, 40 minutes north latitude, such origin being given the coordinates: X equals 2,000,000 feet and Y equals zero feet."

Over the House's laughter Mr. Quesenbury mustered his "explanation": "Why that simply compounds the positive and the negative," he said. "Also there is a formula in the bill by which you can compute the national debt."

Without further explanation, the House unanimously passed the bill.—*The Washington Evening Star*, February 23, 1946.

Federal Surveying and Mapping Agencies

EDITOR'S NOTE.—In response to a number of requests for articles dealing with various aspects of geographic names, we are publishing the following background article on the organization and functions of the United States Board on Geographical Names. The article was prepared by Dr. Meredith F. Burrill, Director of the Board.

U. S. BOARD ON GEOGRAPHICAL NAMES
Department of the Interior

GEOGRAPHIC names are indispensable handles for identifying and referring to places and natural features. It naturally follows that much of the definitive and locative value of the place name is lost if different names or spellings are used for the same place or feature, or if the same name is used for several towns, streams, or mountains.

In the later decades of the 19th century such diversities and repetitions of names were causing so much confusion that steps were taken to remedy the situation for the agencies of the Federal Government, and the original United States Board on Geographic Names was established for the purpose of bringing about uniformity in geographical nomenclature and orthography.

FUNCTIONS AND ORGANIZATIONAL HISTORY

The Board was created by Executive Order of President Benjamin Harrison on September 4, 1890, which gave official status to a committee which had been spontaneously organized by several of the federal bureaus particularly concerned with mapping (1). The Executive Order contains the following statements of purpose:

> As it is desirable that uniform usage in regard to geographic nomenclature and orthography obtain throughout the Executive Departments of the Government and particularly upon the maps and charts issued by the various Departments and bureaus, I hereby constitute a Board on Geographic Names. . . . To this Board shall be referred all unsettled questions concerning geographic names which arise in the Departments, and the decisions of the Board are to be accepted by these Departments as the standard authority in such matters.

The agencies represented on the original Board were the Coast and Geodetic Survey, the Department of State, the Lighthouse Board, the Engineer Corps of the War Department, the Hydrographic Office, the Post Office Department, the Smithsonian Institution, and the Geological Survey. The Board laid down a number of principles and proceeded to attack the most pressing of the problems of geographic nomenclature with which the departments were faced. During the next decade and a half, certain questions concerning the extent of the Board's responsibility were raised from time to time. Some interpreted the language of the Executive Order to mean that only unsettled questions which had arisen in some branch of the Federal Government and referred to the Board came within its purview, and felt that the Board should not consider other names discovered to be in conflict nor proceed further with its investigation of a name than was

necessary to answer the question which had been posed. Their arguments were strengthened by the volume of the work and by the fact that the members of the Board all had responsible full-time positions and that funds were not available for staff and clerical assistance for the Board, so that some means by which the volume of work could be kept from becoming too great a burden seemed to be desirable.

Others, recognizing that to avoid considering all but the most immediate and pressing nomenclature problems simply postponed and made more difficult the ultimate determination of the names, maintained that the fundamental duty of the Board was to bring about uniform usage in regard to geographic names and that the statement about referring unsettled questions was intended to implement this rather than to restrict the Board. This view prevailing, an Executive Order of President Theodore Roosevelt on January 23, 1906, specifically charged the Board with "the duty of determining, changing, and fixing place names" in the areas under the sovereignty of the United States, and with the approval, prior to publication, of "all names hereafter suggested for any place by any officer or employee of the Government. . . ." (2).

Another Executive Order in the same year changed the title of the agency to United States Geographic Board and added to its functions advisory powers "Concerning the preparation of maps . . . with a special view to the avoidance of unnecessary duplications of work; and for the unification and improvement of the scales of maps, of the symbols and conventions used upon them, and of the methods of representing relief" (3). Under this order a set of conventional signs and abbreviations was worked out and adopted, but nomenclature was still the principal concern of the Board. The map advisory functions were rescinded in 1919 by President Wilson and transferred to the Board of Surveys and Maps (4).

An Executive Order of President Hoover in 1931 provided that in draft proclamations and executive orders the geographic names should be spelled in accordance with the most recent Board decisions (5). This was repeated in 1933 in a subsequent order of President Franklin D. Roosevelt (6).

As a part of the reorganization of the Executive Branch of the Government authorized by the Act of March 3, 1933, and the Act of March 20, 1933, President Roosevelt abolished the United States Geographic Board by Executive Order dated April 17, 1934, and transferred its functions, records, etc., to the Department of the Interior (7). Secretary Harold L. Ickes—to provide for the discharge of these responsibilities—set up a Division of Geographic Names in the Department and named to an interdepartmental Advisory Committee on Geographic Names essentially the membership of the abolished Geographic Board. Shortly afterward the Secretary provided by Departmental Order that these two units, the Division and the Advisory Committee, would constitute the United States Board on Geographical Names (8).

Problems of unanticipated magnitude and urgency raised by the war brought a reorganization in 1943. A director was appointed, a staff of geographers, linguists, historians, and clerical and administrative personnel was brought together and steps were taken to assemble indispensable source materials. The Director was authorized to take final action, unless the Secretary should rule otherwise in any particular case, in matters within the framework of established policy (9).

The Advisory Committee was enlarged by the appointment of additional representatives of the Armed Forces and by filling of vacancies to include representatives of the following government agencies and geographical societies: Department of State; Corps of Engineers, War Department; Military Intelligence, War Department; Office of Naval Intelligence, Navy Department; Hydrographic Office, Navy Department; Geological Survey, Interior Department; Coast and Geodetic Survey, Commerce Department; Census Bureau, Commerce Department; Forest Service, Agriculture Department; Post Office Department; Library of Congress; National Archives; Government Printing Office; American Geographical Society of New York; Geographical Society of Philadelphia; Geographic Society of Chicago; and the National Geographic Society. It will be seen that all but two of the agencies represented on the original Board now have members on the Advisory Committee. Other agencies that have been represented at some time in the past are the General Land Office, the Bureau of Foreign and Domestic Commerce, and the Coast Guard.

The functions of the Advisory Committee, as clarified by Departmental Order in 1944, are to review and approve, before final approval by the Secretary, all principles, policies, technical procedures, and name recommendations, and to advise the Secretary generally (10). The same Order established the Division of Geography in the Department, provided that the Division and the Advisory Committee should constitute the Board on Geographical Names, and enumerated the duties of the Division. It formulates principles, policies, instructions, and procedures for both foreign and domestic names, investigates and recommends action on individual names, co-operates with domestic agencies and individuals and with comparable foreign agencies, prepares gazetteers, issues publications, transcribes foreign names on request, maintains master files and furnishes information, and reviews or edits map nomenclatures on request.

By mutual agreement the Advisory Committee receives lists of all names recommended for decision 30 days before they are to be formally approved. If within that period reconsideration of a name is requested the case is referred to the appropriate subcommittee of the Advisory Committee for its recommendation before decision.

The war diverted attention almost completely from domestic name problems that, in view of the large mapping programs definitely planned, now press for solution. As maps are made on larger scales and with greater accuracy of detail, the need for names rises sharply and the difficulty of determining the correct names increases as less well-known features and places are encountered.

Types of Problem Cases

There are a number of types of problem cases, of which the ones with most numerous examples are as follows: Multiple names for the same place or feature; multiple spellings of the same name; multiple spellings of a specific term used with different generics, as for instance, *Tuckasegee River* and *Tuckaseigee*, the village; application of the same name to more than one feature in a category in the same civil division; uncertainty of application or extent of the feature to which the name should be spelled; discrepancies between the names of communities and the names of their railroad stations or post offices; discrepancies between map usage and local usage; discrepancies between present local usage and historical local usage; new name proposals.

The steps in arriving at domestic name decisions are as follows:

(1) Docketing.
(2) Collation of evidence from source materials.
(3) Gathering of evidence of local usage, and of local preference if pertinent to the case.
(4) The determination of points upon which the decision will turn.
(5) Definitive and locative descriptions.
(6) Recommendation on a mimeographed list distributed to the Advisory Committee and to agencies or persons interested in the names under consideration.
(7) Review and recommendation by the Advisory Committee, if request for reconsideration is received within 30 days from the issuance of the recommended name list.
(8) Decision.
(9) Promulgation.

A Domestic Names Program

As stated above, the domestic name phase of the Board's work needs serious and immediate attention. Some features that should be incorporated in a domestic names program are:

(1) Facilitation of use of decisions by collecting all domestic decisions into a cumulative volume and by the preparation of map indexes showing all decisions and the extent of their applicability.
(2) More emphasis on preventive measures that will keep conflicts from arising or resolve the conflicts before serious trouble results.
(3) Consideration of names by groups in a given region which will not only bring to light the relationships of named features but also will permit great economies.

It is also important to recognize that geographical nomenclature is a specialized field, and that investigation of geographical names should be done by skilled personnel trained in techniques embodying modern scientific methods of securing such non-instrumental data.

REFERENCES

(1) Executive Order 29–A, dated September 4, 1890.
(2) Executive Order 399, dated January 23, 1906.
(3) Executive Order 493, dated August 10, 1906.
(4) Executive Order 3206, dated December 30, 1919.
(5) Executive Order 5658, dated June 24, 1931.
(6) Executive Order 6247, dated August 10, 1933.
(7) Executive Order 6680, dated April 17, 1934.
(8) Department of Interior Order 1010, dated December 10, 1935.
(9) Department of Interior Order 1944, dated April 17, 1944.
(10) Department of Interior Order 2002, dated October 28, 1944.

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"THE NEW GEOGRAPHY"

"The new geography is new in materials and devices, and in knowledge of the laws of modern science. But its central principle has remained the same for countless generations. Whether men use the advantages of the earth for good or evil ends is a question in social and political morality. Science leaves the field at this point with a single challenging conclusion: the earth is big enough and rich enough for us all if we learn how to live in peace."—Isaiah Bowman in "The New Geography," *The Journal of Geography*, September 1945.

Land Surveys—Are They Necessary?

By S. PASQUINELLI

VICE PRESIDENT, NATIONAL SURVEY SERVICE, INC., CHICAGO

A CONTRACT or deed, binding most real estate transactions, speaks about a certain lot or parcel of ground in a certain subdivision located in a certain Section, Township, and Range. One of the important questions involved here is: "Does the seller have a good and sufficient title to the property as legally described, and can he make a legal conveyance of same to another party?" An attorney may examine the records of all of the past transactions and render his opinion. A title insurance company may go a step further and guarantee the title, insuring the buyer against any loss due to defects in the recorded title. But, what about the physical existence of the property legally described, its size, location, and questions of surveys? These questions are not usually covered by examining attorneys or by Owners Guaranty Title Policies.

Problems Involved in Real Estate Transactions

How, then, may the buyer satisfy himself as to these questions? Does the legal description used in the deed or contract represent an actual measurable parcel of our good earth? Will the exact placement of its boundaries on the ground cover the property observed and under consideration? Does it cover all the improvements and appurtenances accessory to the premises? Will the boundaries confine or interfere with the full and unhampered use of the sidewalks, drives, easements, stairways, porches, windows, entrance and exit doors, etc.? Is there sufficient space within these boundaries for adequate light and air? Only a plat of survey can answer these questions and reveal the problems which must be solved if both parties (grantor and grantee) are to be happy over the result of the transaction.

I can recall one instance where our survey disclosed that due to a terrace and stairway near the side lot line, it was necessary to swing the automobile side drive into the adjacent lot, in order to reach the garage at the rear. The owner was faced with either cutting down the terrace and stairs or acquiring additional ground to accommodate the drive within the boundaries. The physical conditions allowed no alternative.

A party living in the block next to my home in Glenview bought a beautiful small type house on a 40-foot lot. There was no garage there at the time, but the previous owner had installed a cinder drive along the north side of the house for a parking space. Since the land on both sides of my friend's house was vacant there was nothing to indicate that there was insufficient room for a driveway. A survey was ordered from us in connection with a loan that was being made for this purchase. We found that the net clearance along the north side between the building and the lot line was from 6 to 6½ feet, and on the south side of the house a protruding bay left a clearance of only about 6 feet. The owner needed a garage, and for a wide enough side drive was compelled to seek more ground. The adjoining owner refused to sell him the few additional feet necessary, so he finally acquired the next 40-foot lot to the south. He now has a garage on the north 40 feet and a drive on the south 40 feet of his 80-foot parcel. Though he has a larger property, it is an expensive outlay for an auto driveway.

The H.O.L.C. has had some interesting examples of lack of sufficient area surrounding improvements for proper use and enjoyment of the whole premises. Most of their holdings, of course, have been foreclosed real estate. For obvious reasons, many of the mortgages were made to cover only the minimum amount of ground required to fit the major improvements on the lot. Thus, when foreclosing, the Corporation found itself in possession of only the main buildings in the front area of the lot and without title to the additional buildings or garages at the rear or side. And there is the case publicized in the Chicago newspapers, where the dispossessed original owner moved his entire family and belongings into the garage at the rear of the lot, which was not covered in the mortgage. He certainly created a situation that was not too conducive to the sale of the main premises.

We have made a number of surveys where lot lines fall so close to the improvements that if the adjoining owner erects a fence or any other permanent improvement on or near the lot line he will seriously impair or destroy the utility of door openings, stairways, entrances, porches, and other improvements. Of course, merely looking at the premises does not tell you where the legal property lines fall. Remember, you can't see a property line. Therefore, an observer cannot readily detect any violations of front and side line restrictions or encroachments. Although fences, building walls, drives, and sidewalks may evidence the *probable location* of property lines, they cannot be depended upon for the *true legal location* of the boundary lines unless a survey so discloses.

Gaps, Overlaps, and Encroachments

When conveying any portion of a tract of land it is important to both the grantor and the grantee to know the exact size, shape, and location of the whole parcel, to avoid any unconveyed residue which may result in a *gap*, and to prevent an overconveyance, which would cause an *overlap*. We have made surveys where substantial gaps were found between the property surveyed and a public right of way, thus preventing the free and unobstructed access to a street or alley. In other cases, our survey has disclosed a sizeable gap falling within the boundaries of the whole tract, dividing it into two disconnecting parcels. On the other hand, an overlap may represent an important claim against the subject property by the adjoining owner who may, through the proof of a prior conveyance, acquire undisputed title to the overlapped area. In either case, a gap or overlap may materially reduce the utility of the ground or may completely nullify the intended use of the whole parcel for a specific purpose.

Is the property free and clear of all encroachments? Does any part of the main walls, overhead eaves, or other appurtenances fall beyond the boundary lines so as to encroach on adjoining private or public property? Are there party walls, and, if so, are they within the legal boundaries of the lot? What is the effect of a party wall which falls entirely outside of the boundaries? In some cases we have found buildings that contain no walls whatsoever, making use of adjoining building walls for protection against the outside elements. We have a number of surveys in our files illustrating these actual problems.

Now there is the problem of encroachments on the subject property by improvements located mainly on adjoining properties. Adjoining fences, drives, building walls, and eaves may encroach upon or occupy part of the subject property. Or, we may have the situation where walking, driving, or otherwise repeat-

edly trespassing over and upon any part of the subject premises by adjoining neighbors or the general public has eventually ripened into a permanent easement.

Likewise, the installation and maintenance, by private or public utilities, of sewer, water and gas mains, or overhead and underground power lines, may lead to the same result. Unless vigorously opposed by the owner, this continued use of his property by others, or through encroachments by adjoining owners, may acquire for the trespasser the same legal rights to the property which would be obtained by an actual voluntary deed of conveyance. By the same token, encroachments by the subject improvement into adjoining properties will likely bring litigation to the owner and the possible expense of removing the encroachments, or the purchase of the necessary ground from the adjoining owner to eliminate them.

Ambiguities and Errors in Land Descriptions

We may well conclude from the foregoing that encroachments of any character may present serious problems, resulting in possible litigation either way, and may hinder or wholly prevent the conveyance of what otherwise might be a free and clear title. The purpose of a land survey is precisely to determine on the ground every possible physical fact about the subject and adjoining properties, in relation to the boundaries of the legal description which forms the basis of the particular transaction. When an order for a survey is received we immediately begin the process of analyzing, checking, and searching for errors or defects. Before we leave the office for the field we know, through an examination of the official records, the location of the lot and its recorded size. We are aware of any widening, vacation, or dedication of any street or alley affecting the property.

Recently we received an order from an attorney representing the buyer of a residence in a suburb. The legal description of the property, given to us over the telephone, did not sound quite correct. We know that language sometimes plays peculiar tricks on our minds. The description was written as follows: "The south 1 foot of that part of lot 9 and the north 89 feet of lot 10 lying east of the west 164 feet of said lots, in a certain subdivision, ..." A cursory reading of the description seemed to cover, definitely enough, a 90-foot parcel of ground, running to a depth of the whole lot minus the west 164 feet. A more strict analysis, however, disclosed that it positively described a strip of ground of the proper depth, but only 1 foot wide. Now, this description had been in use for many years and had never been questioned. Upon our recommendation, our client insisted upon, and was finally deeded, a parcel described as: "That part of the south 1 foot of lot 9 and of the north 89 feet of lot 10 lying east of the west 164 feet thereof, ..." The simple transposition and misplacement of the words "that part" made the difference between conveying a 1-foot parcel or a 90-foot parcel of ground.

This type of error is not infrequent. We have had cases where, through careless terminology, the latter part of the legal description completely nullified all or a fraction of the land conveyed in the first part. I am reminded of a survey we made of a South Side property, where the description called for certain lots in a subdivision and ended with certain exceptions. The exceptions appeared to pertain to the subdivision description and not to the particular lots involved. However, it developed that the exceptions affected the specific property in question and actually resulted in the elimination from the center portion of the lots a

50-foot strip of ground. Thus, the front and the rear of the lots were separated by the 50-foot strip. Of course, the main building encroached upon and occupied a goodly portion of this 50-foot strip. We learned later that through some technicality in the title the subdivider had been unable to clear this strip, and, therefore, had to make an exception in his deed description. To our knowledge this description had never been questioned before.

An example of another common type of error occurred on a large apartment building property on the West Side. We were called upon to survey a parcel of land described by metes and bounds, starting from the south line of a lot and thence going north 100 feet; thence west to the west line of the lot; thence south to the south line of the lot; thence east to the point of beginning. According to the official plat of the subdivision, the lots facing the street ran contiguously from Madison Street to Lake Street. Later, Washington Boulevard, Warren Boulevard, and Maypole Avenue were cut through parts of these lots. The south 42 feet of the lot in question was taken for Maypole Avenue, leaving the balance of the lot, starting from the north line of the new street and running north about 175 feet. Upon making a survey on the ground, we found that a large apartment building occupied the area called for in the description, but was based upon a measurement starting from the north line of Maypole Avenue on the assumption that it was the south line of the lot. As a matter of fact, the north line of Maypole Avenue was 42 feet north of the south line of the lot. While it was obvious to us what was intended to be conveyed, we had no choice but to measure from the south line of the lot, as called for in the legal description. This cut through the building 42 feet south of its north wall and eliminated about one-half of the building. The structure was about 15 years old at the time of our survey. The original mortgage had been foreclosed, and the purpose of the survey was to satisfy a buyer who was purchasing the property from the mortgage company. It developed that the original grantor was still alive and willingly accepted a nominal amount for a deed to the part of the property which had not previously been conveyed. This grantor had never intended to convey other than the full amount of the ground subsequently occupied by the building. It was merely a case of a carelessly drawn description, the serious error of which could be detected only by a competent land surveyor. Think of the consequences if the original grantor had passed away or had balked at deeding the remainder of the land.

Property Survey a Protection to Buyer

There are hundreds of similar cases in our files, where unintended errors in legal descriptions, through ignorance of records, loose language, or plain typographical errors, have resulted in serious encroachments, defects in titles, and complication in conveyancing. The process of making a survey uncovers these errors, and through its guidance the proper steps to correct them may be made, thus clearing the way for a good description and a good title. A survey is one of the essential safeguards in any real estate transaction, protecting the buyer and the seller. Without it there is a serious risk for both of them.

One of our clients, a bank official, recently wrote an article about surveys in connection with mortgage loans. His opening paragraph reads as follows:

> For some unknown reason it has not been customary in the Chicago area for sellers of property to furnish plats of survey, nor even for buyers of homes to secure them.

There is some excuse for the ordinary inexperienced person, less excuse for the real estate dealer who is informed, and no excuse for the mortgage man who, though informed, takes chances with his own and his clients' funds.

Most buyers and sellers of real estate are not aware of the questions I have discussed. Moreover, we know that lawyers are not always retained for real estate transactions. The real estate buying and selling public seems to feel that a qualified broker is an expert in his field and is sufficiently informed to handle all problems arising out of the purchase of a parcel of land. There is an implied dependence placed upon him by the buyer and the seller to look out for their interests. Considering that both the buyer and the seller may be his clients, we can agree that a survey is in the interest of both of them, and that it contributes toward a better understanding of the property under consideration. If the survey discloses no complication, then everybody is happier for it. If there are encroachments or technical variations, they should be considered before it is too late, so that through the guidance of the survey and the surveyor the parties can make the necessary adjustments to clear away all possible defects.

Considering that most conveyances may involve the largest single transaction of an individual or family, and often entail the expenditure of life savings, plus the assumption of a long term mortgage or contract obligation, the answer to the question, "Land Surveys—Are They Necessary?" would seem to be obvious.

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The New Electronic Differential Analyzer

THE MATHEMATICS that the engineers of the future are likely to use is expected to come out of the research to be done with the new eletronic differential analyzer of the Massachusetts Institute of Technology, which has just been released from war to peacetime work.

This new mathematical robot, with 2,000 electronic tubes, several thousand relays, 150 motors, and nearly 200 miles of wire in its mechanical "brain," has worked on the development of radar theory, computing range tables for the U. S. Navy guns, and other war tasks.

Now it is to be used on an equally important job. It is free to turn to the task for which it was designed—creating the groundwork for the mathematics of the future.

The mathematics currently used in physics and engineering applications has been devoted to the solution of what mathematicians call "linear" problems, but it has become increasingly evident that the usefulness of these methods has been almost exhausted. They will still constitute the major body of information in handling routine problems.

But the new problems in physics, electrical engineering, aerodynamics, and similar fields seem to be primarily non-linear. Leading mathematicians admit that their principal handicap in handling such problems is that they just don't know enough about the nature of solutions to these problems to make intelligent guesses as to what they are like. From the mathematician's point of view, the major contribution of the differential analyzer and similar computing machines will be to provide the "horse-work" to build up an immense number of detailed numerical solutions to non-linear problems so that the form or shape of the general solutions will become intuitively familiar.

Scientific announcement of the differential analyzer has been made in the Journal of the Franklin Institute in a joint paper by Dr. Vannevar Bush, Director of the Office of Scientific Research and Development, and Dr. Samuel H. Caldwell, Director of the Institute's Center of Analysis.—*Science-Supplement*, November 9, 1945.

A New Idea In Greeting Cards

These cards—received from Mr. Helmuth Bay, Washington representative of Rand McNally & Company—illustrate one of the many uses to which maps can be put. The names are of places actually in existence. The two maps display the original and unique features of Mr. Bay's greeting cards.

Photogrammetry Society Meeting

THE first postwar meeting of the American Society of Photogrammetry was held at the Willard Hotel in Washington, D. C., on January 16–18 and attended by more than 700 members and guests.

The technical sessions of the meeting began on the morning of the 17th with papers on "Photogrammetry and the War," by Colonel P. C. Cullen of the Army Air Forces, Colonel A. G. Matthews of the Corps of Engineers, and Mr. Guillermo Medina of the Hydrographic Office. Colonel Cullen reviewed accomplishments of the Air Forces during the War and its contribution to photogrammetry. He also outlined some of the improvements in cameras and planes which we might reasonably expect in the future. Colonel Matthews stressed the need for accurate maps in military operations and gave several good illustrations as to how misplacement of map features can influence these operations. Mr. Medina gave an interesting summary of the work of the Hydrographic Office and the importance of photogrammetry in the preparation of maps and charts for landing operations.

At the afternoon session papers were presented on "Postwar Plans" by representatives of the various federal agencies. Admiral L. O. Colbert, Director of the Coast and Geodetic Survey, stressed the need for extension of control surveys and the benefits that would accrue from a co-ordinated mapping program. Admiral G. S. Bryan of the Hydrographic Office outlined the plans of the Hydrographic Office for procuring better marine charts in areas hitherto inaccessible to us. Dr. T. B. Nolan of the Geological Survey—substituting for Dr. Wrather—revealed for the first time the general plan for completion of topographic mapping of continental United States and its possessions. General D. F. Johns of the Corps of Engineers stated that it was not the intention of the Corps of Engineers to devote its efforts to domestic mapping but that it would gladly give its support to a well co-ordinated program that would insure completion of topographic mapping in the United States and its possessions. Mr. R. H. Randall of the Bureau of the Budget outlined the interest of the Bureau in a general mapping program. He credited the geologist for his efforts to secure more accurate maps and fortunately his demands can be supplied today largely through the tools of photogrammetry at hand. Mr. M. S. Wright of the Department of Agriculture spoke on the needs of the Department and emphasized the desire of the Department to confine its mapping to specialty needs rather than to topographic mapping in general.

At the morning session of the 18th Mr. Talbert Abrams, of the Abrams Industries, spoke on "Commercial and Private Photogrammetry in Europe" based on a recent extensive tour there. "Large-scale Maps and Photographs for Industrial Planning" was discussed by Mr. Virgil Kauffman, of Aero Service Corporation. He reviewed some of the programs carried out by his company during the war, and also spoke briefly on the use of glass and film negatives and the need for improvement of film as well as lenses. The morning session closed with an informal discussion of photogrammetry and its application to oil research.

At the closing session of the meeting a paper on "Canadian Survey Practice" was presented by Major C. C. Lindsay, president-elect of the Canadian Institute of Surveying. He reviewed the many difficulties involved in Canadian survey practice and the application of photogrammetry to some of these problems. "German Photogrammetry in the War" was presented by Colonel FitzGerald and Mr. Russell Bean of the Geological Survey, both papers being based on first-hand infor-

mation obtained shortly after V–E day. Colonel FitzGerald stated that in Germany all private photography was combined into a government organization in 1934. He also pointed out that apparently considerable use was made of mosaics, due mostly to the lack of trained personnel in the use of photogrammetry and its application to the preparation of maps, and that little or no work had been done in tri-metrogon photography. Mr. Bean found that most of the mapping was being done with the stereoplanagraph, and that little progress had been made in Germany with the Multiplex since development of the original plotting instrument. In his estimation photogrammetry in the United States has certainly equaled, if not well surpassed, that of Germany.

A feature of this year's meeting was the elaborate exhibit of maps, charts, mosaics, relief maps, and equipment by the various private photogrammetric organizations and federal agencies. Among the many exhibits was a gyroscopic controlled camera mount developed by the Army. It was explained that experimental results with this apparatus in obtaining practically true vertical aerial photographs have been extremely encouraging. Captured German equipment indicated the trend of development in that country during the war. A wide angle (Pleon) lens was exhibited. This lens covers an angle of more than 140 degrees. On a photograph taken at 20,000 feet altitude with this lens, more than 300 square miles appear on a single vertical photograph. A tiny gun sight camera, recently developed by the Abrams Instrument Corporation of Lansing, Michigan, was also exhibited. About the size of a penny match box, this camera takes 500 photographs on a single roll of film.

The Fairchild Award for outstanding development during the year of new mapping apparatus was awarded to Mr. J. E. King of the U. S. Forest Service for his work on photo-transits. The Abrams Award, for the best article appearin *Photogrammetric Engineering* during the year went to Mr. Revere G. Sanders, of the Fairchild Camera and Instrument Corporation, for his article on the development of stereoscopy.

The newly elected officers for 1946 are: President—Colonel Gerald FitzGerald; First Vice President—Revere G. Sanders; Second Vice President—R. M. Wilson; Secretary-Treasurer—Eugene Schlatter.

J. O. KILMARTIN

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"The Graphic Arts in Contemporary Mapping"

"The Graphic Arts in Contemporary Mapping" exhibit at the New York Public Library was concluded on January 31. The exhibit was sponsored by the American Institute of Graphic Arts and the Public Library.

Of special interest was the military section of "Now it Can be Told" materials, such as maps captured from the Germans and Japanese, survival "handkerchief" maps carried by fliers, life-raft charts, invasion rubber relief models, fluorescent maps in a darkroom, and other interesting wartime developments in mapping. In addition the displays included journalistic cartography and new cartographic techniques, such as special relief and color treatments.

Contributions to the Graphic Arts Exhibit were made by the Army Map Service, Hydrographic Office, Geological Survey, Coast and Geodetic Survey, Soil Conservation Service, the Aeronautical Chart Service of the Army Air Forces, American Geographical Society, and the New York Public Library.

American Geophysical Union Adopts Resolutions on Surveying and Mapping

The following Resolutions dealing with surveying and mapping were unanimously adopted at the Twenty-sixth Annual Meeting of the American Geophysical Union, at Washington, D. C., June 1, 1945.

—EDITOR

RESOLUTION ON CO-OPERATION BETWEEN NATIONS IN THE INTER-CONTINENTAL CONNECTION OF GEODETIC MAP-CONTROL SYSTEMS

WHEREAS, The welfare and the improvement of the standards of living of all peoples are largely contingent upon the more rapid and efficient discovery and production of useful minerals—including ores and fuels, and

WHEREAS, The needed improvements in the world's geological and geophysical methods for discovering and developing such useful mineral raw materials can be notably facilitated through the co-operative extension and inter-continental linkage of the world's several regional geodetic map-control systems, therefore be it

RESOLVED, That the American Geophysical Union express the hope that the President of the United States will consider how our Nation can make practical contribution to world-peace and to the advancement of all peoples through the working out of international co-operative arrangements for the inter-connection of the Eurasian and North American geodetic map-control systems; by linkage across Bering Strait; and for similar extensions and inter-connections of geophysical and geodetic map-control systems throughout the Americas, and be it further

RESOLVED, That a copy of this resolution be duly forwarded to the National Research Council with the request that it be transmitted to the President of the United States.

RESOLUTION ON MAPPING BY THE U. S. COAST AND GEODETIC SURVEY AND THE U. S. GEOLOGICAL SURVEY

WHEREAS, About one-half of the United States and its territories and possessions is totally unmapped and more than two-thirds of its area of three million square miles is inadequately mapped, and

WHEREAS, The needs for maps for national planning and other peace-time purposes are certain to be far greater with the passing of each year, and

WHEREAS, Mapping as a public works project, properly accomplished, will effect great savings in national economy of ultimate benefit far exceeding its cost, and

WHEREAS, There is great waste resulting from this lack of maps which inevitably accumulates, and will continue to do so with serious consequences, therefore be it

RESOLVED, by the American Geophysical Union assembled in Washington June 1, 1945, that this matter be called to the attention of the President of the United States with the urgent recommendation that the necessary appropriations be made for this work to be undertaken jointly by the United States Coast and Geodetic Survey and the United States Geological Survey working in co-operation to expedite the work within a reasonable number of years, and be it further

RESOLVED, That copies of this resolution also be forwarded by the Secretary of the American Geophysical Union to the President of the Senate, the Speaker of the House of Representatives, the Director of the Bureau of the Budget, and the Secretaries of Interior and Commerce.

RESOLUTION ON SUGGESTED FEDERAL MAP INFORMATION AND DISTRIBUTION OFFICE

WHEREAS, The emergency conditions existing during the past few years have made it necessary for many of the federal surveying and map-making agencies to take part in the topographic mapping of certain important areas in the United States, and

WHEREAS, These same conditions have prevented adequate dissemination of information regarding the location of the areas surveyed and the availability of the resulting maps and

WHEREAS, The map-using public is at present seriously handicapped by its inability to obtain all topographic maps from a single source (the United States Geological Survey) as formerly, or to obtain definite information as to what agency distributes the maps or charts needed and is therefore frequently put to unnecessary expense and annoying delay in securing these maps or charts, be it therefore

RESOLVED, That the American Geophysical Union recommend the formation, within the framework of existing federal agencies, of a map information and distribution office responsible for furnishing accurate and complete information regarding all maps, charts, and aerial photographs published or procured by the several federal surveying and mapping agencies; and for the actual distribution of all topographic (quadrangle) maps of the United States and its possessions now published and distributed to the public by numerous federal agencies, and be it further

RESOLVED, That copies of this resolution be sent to the Bureau of the Budget; to the Chief Examiner, Surveying and Mapping, Bureau of the Budget; to the American Congress on Surveying and Mapping; and to all federal surveying and mapping organizations.

RESOLUTION ON POSTWAR INTER-DEPARTMENTAL MAP BOARD

WHEREAS, The maps and charts of the United States and of navigable waters adjacent thereto are of the utmost importance in time of war, both to the Armed Forces and to civilian contractors, operators, and public carriers, who directly and indirectly supply the Armed Forces with munitions of war, and

WHEREAS, The severe restrictions placed on the distribution of certain types of maps and charts and the withholding of vital information necessary in constructing charts and maps have created a large amount of confusion and delay in supplying adequate charts and maps to contractors, engineers, navigators, and pilots, and have deprived the public of other useful information often resulting in duplication at heavy expense of data already existing, and

WHEREAS, Much of this confusion and delay has resulted from not having in advance an Inter-departmental Board with authority to fix security policies pertaining to the preparation and distribution of charts and maps, therefore be it

RESOLVED, That the American Geophysical Union urge that, at the conclusion of the war, an Inter-departmental Board, composed of representatives from the Army and Navy and representatives from each of the federal surveying and mapping agencies, be established to make a thorough study of the entire subject of map and chart classification and restriction, and to prescribe definite policies to be followed during future periods of emergency, and be it further

RESOLVED, That copies of this resolution be sent to the War and Navy Departments; to the Bureau of the Budget; to the Chief Examiner, Surveying and Mapping, Bureau of the Budget; to the chairman of the Inter-departmental Board; to Clifton A. Woodrum, Chairman, Postwar Military Policy; to the American Congress on Surveying and Mapping; and to all federal surveying and mapping agencies.

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WHY NOT ENROLL ONE NEW MEMBER IN THE CONGRESS?

Surveying and Mapping News

Members are requested to send in surveying and mapping news items for publication in SURVEYING AND MAPPING.—EDITOR.

CURRENT SURVEYING AND MAPPING LITERATURE

MAGAZINE ARTICLES

ORIGIN OF SECTIONS, TOWNSHIPS, AND RANGES GOES BACK TO COLONIAL DAYS. (In two parts.) Frank J. Cordes, *California Highways and Public Works*, November–December 1944, January–February 1945. (The historical background for the adoption of the present system of subdividing the public lands of the United States.)

AIR PHOTOGRAPHY AND ARCHAEOLOGY. J. K. St. Joseph, *The Geographical Journal* (London), January–February 1945. (Describes the uses of low altitude aerial photos, both oblique and vertical, in studying the remains of earthworks, village sites, agricultural systems, roads, ditches, and other features dating from Neolithic to Medieval times.)

TRIMETROGON PHOTOGRAMMETRY. John Carroll, *The Canadian Surveyor*, January 1945. (Describes briefly the organization of the Alaskan Branch of the U. S. Geological Survey for trimetrogon mapping. Also describes the Canadian trimetrogon work with special reference to the method of tilt analysis developed by the Bureau of Geology and Topography.)

LOCATING CONTROL POINTS FOR AERIAL MAPPING IN NORTHERN CANADA. B. J. Woodruff, *The Canadian Surveyor*, January 1945. (Deals with a method of locating ground control points which combines the use of astronomic observations, ground survey, and aerial photography.)

ONTARIO HIGHWAYS. W. J. Fulton, *The Canadian Surveyor* (Special Edition, February 1945.) (A brief review of the road construction program including postwar construction. Discusses maps and surveys necessary in highway planning and the procedure followed in laying down a highway.)

RESURVEY IN THE PROVINCE OF QUEBEC. Marcel Ste. Marie. *The Canadian Surveyor* (Special Edition, February 1945). (Discusses resurveying old lines established on Crown lands with a brief review of the history of surveys in Quebec.)

MAPS FOR THE DEVELOPMENT OF NATURAL RESOURCES. K. B. Brown, *The Canadian Surveyor* (Special Edition, February 1945).

PHOTO MAPS. Virgil Kauffman, *The Canadian Surveyor* (Special Edition, February 1945). (A discussion of aerial photographic mosaics including a review of the specifications adopted by the U. S. Soil Conservation Service for the production of mosaic maps.)

NEW ROLE OF AERIAL PHOTOGRAPHY. Wilbur H. Simonson, *Civil Engineering*, May 1945. (Wartime experience, by making possible accurate contour mapping at

larger scales than heretofore, has made aerial photographic surveying useful and economical in location and design stages of highway and related work. Discusses combination of aerial and ground surveys in a complete operation.)

THE ARMY MAP SERVICE LIBRARY—MAP CATALOGING. Mary Murphy, *Special Libraries,* May–June 1945.

ENGINEERING ACHIEVEMENTS IN WAR AND PEACE. Louis H. Berger, *The American Engineer,* July 1945. (An appraisal of the engineer's place in postwar reconstruction.)

USE OF AERIAL PHOTOGRAPHS. Albert Lane, *The Military Engineer,* July 1945. (Discusses the indispensability of stereoscopic study of aerial photographs in advance planning and for tactical and engineering construction purposes; describes a plan of use in the establishment of a forward base; cites incidents which occurred in the Southwest Pacific area operation.)

RIGHT OF WAY FOR HIGHWAYS. E. W. Murray, *The Canadian Surveyor,* July 1945. (Describes some of the problems connected with establishing right of ways for highways in Canada.)

TWO NEW TYPES OF THEODOLITES. Ontario Hughes-Owens Co. Ltd., *The Canadian Surveyor,* July 1945.

SAG CORRECTIONS SIMPLIFIED. R. Thistlethwaite, *The Canadian Surveyor,* July 1945. (Describes method of constructing table from which correction for sag can be obtained from the length in sag as argument.)

LAS CARTAS GEOGRAFICAS Y SU EVOLUCION. Horacio Herrera, *Boletín de la Sociedad Mexicana de Geografía Y Estadística,* July–August 1945. (A general discussion of the development of cartography including the reproduction of maps.)

REPORT OF SPECIAL COMMITTEE ON PRECISE SURVEYS AND MAPS, 1944–45. *Transactions, American Geophysical Union,* August 1945. (Appendix E.) (Gives results of a study made for the American Geophysical Union. Resolutions adopted by the Union are published elsewhere in this issue.)

CAREFUL PHOTOGRAPHY IS BASIS OF FINE OFFSET. R. Ernest Beadie, *The Inland Printer,* September 1945. (Deals with precautions which should be taken in photography to achieve the best lithographic results.)

PLACE NAMES OF THE CALIFORNIA GOLD RUSH. H. F. Raup, *The Geographical Review,* October 1945. (827 place names in four counties in California were studied to ascertain tendencies in geographical nomenclature among the early miners.)

AERIAL RECONNAISSANCE. Alan M. Eldridge, *Military Review,* October 1945. (A detailed presentation of the activities and achievements of military reconnaissance aviation as an information-producing agency.)

MILITARY APPLICATIONS OF PHOTO-GEOLOGY. Richard D. Dirmeyer, Jr., *The Military Engineer,* October 1945. (Describes the use of aerial photographs, by Military Intelligence, for solving terrain problems in the Pacific Area.)

KEY TO A BETTER UNDERSTANDING OF MAPS, III. William H. Gill, *The Military Engineer,* October 1945. (The third in a series of articles on this subject. Describes the major cartographic fields and mapping activities of the Federal Government including mapping methods and forms of presentation.)

A SURVEYOR TURNS TO PHOTOGRAMMETRY. John Carroll, *The Canadian Surveyor*, October 1945. (Describes some of the data the control surveyor should obtain to make the survey of maximum value to the photogrammetrist.)

NON-REFLECTING FILMS ON TELESCOPIC LENSES. C. H. Ney, *The Canadian Surveyor*, October 1945. (Describes how optical efficiency of telescope lenses can be materially improved by coating with thin films of transparent material. Gives results of recent comparative tests.)

RECTANGULAR COORDINATES. A. O. Este, *The Canadian Surveyor*, October 1945. (Pleads for the adoption of some system of rectangular plane coordinate surveying to perpetuate accurate co-ordinated surveys.)

SAFEGUARDING OUR SEAWAYS—THE MODERN NAUTICAL CHART. A. L. Shalowitz, *The Scientific Monthly*, October 1945. (Discusses the early influences on contemporary chart making and describes some of the methods used by the Coast and Geodetic Survey in surveying and charting the areas under its jurisdiction.)

EQUAL-AREA PROJECTIONS AND THE AZIMUTHAL EQUIDISTANT PROJECTION IN MAPS OF DISEASE. Saul Jarcho, *American Journal of Public Health*, October 1945.

CONVERSE OF PTOLEMY'S THEOREM ON STEREOGRAPHIC PROJECTION. Edward Kasner and John DeCicco, *Proceedings of the National Academy of Sciences*, October 1945.

WHAT IS IN THE MILE BEHIND AN INCH ON A MAP OR GLOBE. Mamie L. Anderzhon, *The Journal of Geography*, October 1945. (A report suggesting activities designed for junior high-school pupils to promote understanding of distance behind the scale of miles on a map or globe.)

MAGNETIC COMPASS ADJUSTMENT BY STARS. Hayden Crocker, *United States Naval Institute Proceedings*, October 1945.

RADAR AND LORAN. *The Ships' Bulletin*, October–December 1945. (Reproduced from the U. S. Coast Guard Bulletin, November 1945. Describes the principles of these electronic devices and how they can be used as aids to navigation.)

BOOKS AND PAMPHLETS

GEOLOGY FOR EVERY MAN. Albert Seward. *The Macmillan Company*, New York. 1943. 312 pages. $3.25. (A semi-popular account of the geology of Britain as seen during a series of journeys through the country side.)

FOUNDATION OF CARTOGRAPHY: General Section. K. A. Salishchev. *Publishing Office for Geodetic and Cartographic Literature*, Moscow. 1944. Second edition. 367 pages.

BRITISH MAPS AND MAP-MAKERS. Edward Lynam. *William Collins, Sons and Co. Ltd.*, London. 1944. 48 pages. Price 4*s*. 6*d*. (A brief history of British cartography.)

GLOBAL GEOGRAPHY. George T. Renner and Associates. *Thomas Y. Crowell Company*, New York. 1944. 728 pages. $3.75. (A book written to give to Americans the ability to view peoples, nations, and theaters of current events in their appropriate environmental settings and to observe, classify, analyse, and solve political and other problems in terms of local, regional, and global relationships.)

THE STORY OF THE GREAT GEOLOGISTS. Carroll Lane Fenton and Mildred Adams Fenton. *Doubleday, Doran and Company,* New York. 1945. 301 pages. $3.50. (A series of biographical accounts of selected outstanding men who dealt with the earth as a whole, or with features of such magnitude that they influence all geologic thought.)

AERONAUTICAL ENGINEERING CATALOG. W. A. Shrader, Editor. *Institute of Aeronautical Sciences,* New York. 1945. Second edition. 644 pages. (A valuable reference book distributed as a free service by the Institute.)

NAMES ON THE LAND: A Historical Account of Place-Naming in the United States. George R. Stewart. *Random House,* New York. 1945. 418 pages. $3.00.

WORLD GEOGRAPHY. John H. Bradley. *Ginn and Company,* Boston. 1945. 486 pages, maps, pictures, charts, and diagrams. $2.48. (Deals with *human* geography to meet the growing need for broader geographical training in secondary schools.)

AIR-AGE GEOGRAPHY AND SOCIETY. James Franklin Chamberlain. (Revised edition by Harold E. Stewart.) *Lippincott,* Chicago. 1945. 717 pages. $2.12. (A high school textbook with emphasis on global perspective. Revision of "Geography and Society.")

THE CLASSIFICATION AND CATALOGING OF MAPS AND ATLASES. Samuel W. Boggs and Dorothy C. Lewis. *Special Libraries Association,* New York. 1945. 175 pages.

BOOKS RECEIVED

GENERAL THEORY OF EQUIVALENT PROJECTIONS (U. S. Coast and Geodetic Survey). Oscar S. Adams. *U. S. Government Printing Office,* Washington, D. C. 1945. 74 pages. $0.30. (To be reviewed in a later issue of SURVEYING AND MAPPING.)

PRACTICAL AND THEORETICAL PHOTOGRAPHY. Julian M. Blair. *Pittman Publishing Corporation,* New York. 1945. 243 pages. $2.50. (To be reviewed in a later issue of SURVEYING AND MAPPING.)

DISTINCTIVE RECENT MAPS

The U. S. Geological Survey is continuing the publication of two new series of maps: (1) strategic minerals investigations and (2) oil and gas investigations. The former, which show geology and cover special areas in great detail, both in the United States and in Alaska, were started in the wartime rush to discover further sources of essential minerals. The oil and gas investigations are assuming formidable proportions. They consist of charts showing columnar sections and of maps giving geology and structural contours, and in many instances terrain topography as well. Preliminary map 42 is a good illustration: it shows the geology of northwest Oregon (1:150,000) and also land contours of 300-feet interval. Notice of these maps will be found in the monthly Publications List issued by the Survey. New editions of the oil and gas maps of the states of Illinois and Wyoming (1:500,000) have also been issued.

Although they appeared in 1940, it is not widely known that the Bureau of the Census has published a set of twenty state maps (1:1,000,000) showing irrigation by drainage basins, as part of the Census of Irrigation, 1940. Drainage basins are outlined in red, and figures give the acreage irrigated, as of 1939. The survey comprises seventeen western states, as well as Arkansas, Louisiana, and Florida, and there is also a general map of western United States on a scale of 1:3,500,000.

Continuing the publication of land-cover maps of the State, the Wisconsin State Department of Agriculture, Land Use Section, has issued a series for the counties of Buffalo and Door, on the scale of one inch to the mile. The maps are by townships, assembled in plat-books, and the data used were taken from the original survey plats and field notes, aerial photographs, and the land inventory field sheets. Other maps published in this series which was started about 1934, cover the counties of Kenosha, Oconto, Racine, Waukesha, and Waushara.

With the publication of the "Bogota" sheet in December 1945, the American Geographical Society's Map of Hispanic America on the scale of 1:1,000,000 (in 107 sheets) was brought to completion after a quarter of a century of work. A complete description of the undertaking appears in the January 1946 issue of *The Geographical Review*.

An interesting series of bathymetric maps of the Norwegian coastal waters has been received from the Norske Videnskaps-Akademi in Oslo. Published in 1940, the seven sheets accompany a work of Olaf Holtedahl, "The Submarine Relief off the Norwegian Coast." The sheets are of various sizes and on scales ranging from 1:360,000 to 1:550,000. Eight grades of bathymetry are shown, as well as the character of the ocean bottom.

The Association for Planning and Regional Reconstruction in London has issued a collection entitled "Maps for the National Plan," in connection with the Barlow, Scott, and Beveridge reports (119 pp.; Lund Humphries & Co. Ltd., London, 1945). The maps, designed to provide a background for discussion and criticism of plans for postwar reconstruction, present information derived from government publications and other official sources. Factors shown include climate, population and employment statistics, administrative boundaries, the electric grid, extractive industries, trade, and transport. The maps are in black and white, and two transparent maps are provided in the back pocket showing chief urban areas and the 1938 distribution of population.

The December 1945 issue of *Serial Map Service*, has a map on page 26 illustrating the Scottish Hydro-Electric Board's "Project No. 25," which has received Parliamentary approval. It involves the rivers Garry and Tummel above Pitlochry in central Scotland, and shows proposed aequeducts and pipe lines, dams, and reservoirs.

The Société des Sciences Naturelles du Maroc, in Rabat, has issued a new rainfall map of Morocco, edited by Georges Roux, head of the Service de Physique du Globle et de Météorologie de l'Institut Scientifique Chérifien, on which ten grades of rainfall are shown. (Maroc au 1,500,000e, moyenne annuelle des précipitations, période 1926–1940; Rabat, Institut Scientifique Chérifien, 1943.) The map is accompanied by 19 pages of explanatory text.

—JOHN K. WRIGHT

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Surveyors' Short Course

THE DEPARTMENT OF CIVIL ENGINEERING, University of Tennessee, is planning a short course in Surveying to be held at the University, Knoxville, April 12 and 13. The effort is to interest and bring to this meeting the county surveyors, and private and municipal engineers from over the State. The Tennessee Valley Authority is co-operating in this effort and some of the engineers from that organization will participate in the program.

The subjects for discussion will include the following: Use and Care of Surveying Instruments; Traversing—The Field Work and Computations; Field Problems in Surveying; Legal Aspects of Land Surveying; Magnetic Declination and Its Variations; Mapping for War and for Peace; The State Coordinate Systems; Observations for True Meridian; The Transit (film strip)—How and Why It Operates and Its Cleaning and Lubrication.

Book Reviews

ELEMENTS OF MAP PROJECTION—With Applications to Map and Chart Construction. (Special Publication No. 68, U. S. Coast and Geodetic Survey, Fifth Edition). Charles H. Deetz and Oscar S. Adams. *U. S. Government Printing Office,* Washington, D. C. 1945. 226 pages. $1.00.

Reviewed by C. F. Fuechsel, Chief, Map Information Office,
U. S. Geological Survey, Washington, D. C.

As one of the "best-sellers" in the cartographic field this publication needs no introduction to those engaged in the various phases of map construction. Indeed, the subject of map projection has been popularized by a global war and international affairs to the extent that even the general public is now somewhat familiar with the cartographer's problem of presenting a spherical surface in the plane. The appearance of featured articles on maps and global cartography, the excellent perspective illustrations by Harrison, Chapin, and others, and graphic analyses of the properties of various projections, have admitted the laity to this erstwhile cloistered habitat of the professional cartographer.

Although the basic problems of map projection and characteristics of the better known projections are lucidly—and insofar as possible simply—presented in the publication under review, it is more a treatise for the professional cartographer than for those interested in a cursory review of the subject. For the latter, Special Publication No. 60 (U.S.C. & G.S.), A Study of Map Projections in General, is recommended. This earlier work by Dr. Adams is available from the Government Printing Office and deals with the general aspects of the subject in a pocket-sized pamphlet of 24 pages. For the surveyor whose interest in map projections concerns their relationship to plane coordinate systems, Special Publication No. 235, which was reviewed in the October 1945 issue of Surveying and Mapping, is recommended.

The fifth edition of Special Publication No. 68, which in this country has become the standard reference text on map projection, is similar in arrangement and general coverage to the earlier editions but now contains more than a hundred figures and special plates illustrating the fundamental problems of projection and presenting specimen developments of the better known systems. One new plate shows the different properties of the Lambert and Mercator projections by superimposing one on the other with their respective delineations of the United States. Another plate illustrates a new equal-area projection of the hemispheres by Dr. Adams. The interesting property of isoperimetric curves (curves of true scale), which is inherent in all equal-area projections, is presented for the first time in this work, as applied to the Albers and sinusoidal projections.

A section has been added comparing the perspective projection on a tangent cylinder with the Mercator projection, including two maps of the world drawn to the same scale showing the differences in the two projections. The authors have done cartography a distinct service in rectifying the misconception that has grown up that the Mercator projection is a projection on a tangent cylinder. It is well worth quoting the authors' statement on this: "In this mathematical transformation Mercator did not employ a tangent cylinder nor is it ever employed in this projection. This conception did not originate with him, but is a later invention. The statements to this effect that appear in many textbooks may be dismissed as erroneous and misleading."

The résumé of the systems of map projection, which was introduced with the fourth edition, has been expanded with interesting commentaries upon the choice of projections for aeronautical charts and other map series produced during the war. It should also be noted that the fifth edition has been published in the more convenient octavo size—earlier editions having been published in quarto.

Part I deals with analysis of the basic elements of map projection, construction of simple geometric figures, the development of conical and cylindrical surfaces, and other fundamental reference media for projection of the spheroid.

Part II gives a comprehensive description of the nature, properties, and construction of the systems of map projection now generally used. Some tables are included, suitable for the construction of very small-scale maps of countries, hemispheres, or the whole spheroid.

More exhaustive discussions and analyses of the projections used most extensively are available in several other special publications of the U. S. Coast and Geodetic Survey, but this publication affords a comprehensive treatise covering the whole field to the satisfaction of most map makers and map users. A bibliography gives the student of projection access to a formidable array of treatises among which his thirst for knowledge in this field can be indulged.

MAGNETISM OF THE EARTH. (Serial 663, U. S. Coast and Geodetic Survey.) Albert K. Ludy and H. Herbert Howe. *U. S. Government Printing Office,* Washington, D. C. 1945. 77 pages. $0.35.

Reviewed by G. Brooks Earnest, Associate Professor of Engineering Surveying, Case School of Applied Science, Cleveland, Ohio

THE AUTHORS have successfully concentrated and abstracted important criteria related to the magnetism of the earth in the small space of 75 pages. It makes interesting reading and is sufficiently informative for those who are concerned with engineering or navigational problems.

The writer offers one criticism in the matter of sequence of presentation. Usually origin, history, and development precede expanded basic factors. To one who has limited use for the subject, Chapter VI, Origins of Geomagnetic Science, proffers incentive to complete the text, and accordingly should have space following the introduction.

A number of facts not generally noted in surveying texts have been presented in Chapter II, The Earth's Permanent Magnetic Field and its Secular Change. It is evidenced that the existence of the earth's magnetic field and its variations baffle specialists in the field of physical science.

In line with progress in scientific research, the compass, without doubt, may be recognized as one of the greatest assets to modernization of marine navigation. Undoubtedly it will always be used as a chief means of navigation in some craft, and as a supplementary means in other craft. The trend is toward modernization—just as the compass has decreased in value as a precision instrument in surveying, so also is it being replaced by the gyroscopic or automatic pilot aids, in navigation. The value of the compass is practically nil in aircraft in high latitudes.

The writer is of the opinion, nevertheless, that the compass will always possess value as a means of navigation in smaller craft and as a means of checking courses in larger craft. It will maintain its place as a check on the bearings in transit surveys. Accordingly, the vast amount of research data obtained by the U. S. Coast and Geodetic Survey and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington will have infinite use. In addition, these and other agencies of other countries should continue the outstanding research in this direction, inasmuch as there are a number of unknown or inexplainable elements still worthy of the attention of those specializing in this field. Now that the global war has ended, a renewal of the research activities in magnetic observations is highly desirable, especially in certain ocean areas where approximately twenty years have lapsed since last observations were executed. Furthermore, it

will be highly desirable for the U. S. Coast and Geodetic Survey to re-edit this publication upon accumulation of new data and research results sufficient to warrant it.

BOUNDARY-MAKING: A Handbook for Statesmen, Treaty Editors and Boundary Commissioners. Stephen B. Jones. *Columbia University Press,* New York. 1945. 268 pages. $3.00.

"Foreword" by S. Whittemore Boggs, Chief, Division of Geography and Cartography, Department of State, Washington, D.C.*

DR. JONES has written a "first aid" handbook for all who have responsibilities in making or maintaining boundaries. Such a reference work has long been needed, but there has never been a better time to prepare it than now.

Those who are drafting or negotiating treaties must consider allocation of territory (with reference to local populations, railroads, roads, access to markets, water supply, mines and mineral resources, and other factors); they must fix upon a precise line or, as is frequently better, a narrow zone within which the boundary is to be laid down (involving questions of linguistic boundaries, river or mountain or geometrical boundaries, trade frontiers, and the like); they must describe boundaries in terms that are equally precise and unambiguous to lawyers and civil engineers; if information should be obtained in the field and report made before the treaty is concluded they will wish to learn what to request and how to get it; and they usually provide for the creation of a commission to demarcate the boundary. In connection with all these aspects of their responsibility statesmen and treaty negotiators will be anxious to draw upon the history of boundary disputes the world over in order to avoid, if possible, future sources of friction and misunderstanding from which serious situations may arise.

The members of demarcation commissions desire to know how best to exercise their discretion in adapting the boundary to local requirements, if they are thus fortunately empowered; provision must be made for settlement of disputes among the members and for filling vacancies; time-limits may well be imposed; services of supply while they are in the field must be provided, and sometimes police escort as well; boundary monuments and reference marks must be established; reports and maps must be prepared. Finally, boundary monuments and "vistas" should be periodically inspected and maintained, and boundaries should be administered in such manner as to avoid friction and serve the local populations and the governments of the two states.

Railroads and roads, the "ribbons of land dedicated to movement," are laid out by engineer specialists. International boundaries, some of which are fabricated obstacles to the movement of human beings and their goods and ideas as formidable as the Alps, are not made by professional boundary-makers, as no such profession is recognized or established. There are today, however, more than 100,000 miles of international boundaries in five continents, and there have been tens of thousands of miles that have disappeared from the map, which are of infinite variety as to topography, human elements, and boundary functions. But it may sometimes seem hopeless to statesmen and boundary commissioners to glean coveted wisdom from the vast, unorganized literature.

This modest-sized handbook is written for busy men, many of whom face boundary problems for the first time. For more extensive reading, the footnotes and the sources therein cited are worthy of attention. Although the bulk of the book deals with practical details of boundary-making, there is perhaps no better brief introduction, in any language, to the whole field of boundaries and boundary-making than Part I, "The General Situation," in this volume. As a geographer with appreciation of the importance of

* Reprinted from "Boundary-Making" through the courtesy of the Carnegie Endowment for International Peace.

field studies, Dr. Jones stresses the value of first-hand knowledge based on adequate work in the area concerned. Each boundary is almost unique, and therefore many generalizations are of doubtful validity. The author is well aware that a boundary is not simply a line on the ground, but a line in a zone of transition. Our boundary problems would not be what they are "if man were not so fond of circulating." There is discussion of the concept of a boundary as a line of contact of territorial power structures and of recent restrictions on trade which give "new and even more ill-fitting functions to boundaries already anachronistic." Juggling territory leads to no final solution. For that, if it ever is attained, he believes that "new concepts of sovereignty and of boundary functioning seem necessary."

Boundary problems are covered vertically as well as laterally. The author deals with questions of "overhead sovereignty," and of sovereignty and boundary administration in mine shafts at different levels, observing that "the problems of minerals in the modern world cannot be solved equitably without new types of international cooperation." He has not overlooked problems that may arise with the commissions in the field, such as health, morale, and the means of settling disputes between commission members.

Boundaries and boundary problems have undergone great changes. When Marco Polo crossed frontiers from one jurisdiction to another there were no precise boundaries like those of our time. Even a century and a half ago the international boundary picture bore little resemblance to that of today. In Asia there were few treaty or other definite lines, but only fluctuating limits of various kingdoms. Africa, then the great unknown continent, knew no boundaries other than the self-imposed limits of Ottoman dominion in North Africa, border marches between a few native kingdoms, and indefinite hinterlands of a few scattered coastal "factories" of rival European colonial powers. In the Americas there was the Spanish-Portuguese line in South America, and in North America the ill-defined boundary between the United States and Canada extending only half way across the continent. European boundaries were then, as now, the most numerous and definite, but they have greatly changed in location and in function in the intervening years. European boundary concepts have proliferated until they now extend to nearly all international boundaries in all continents.

The author has produced a very readable book which is distinctly his own contribution to the literature. Men who have present boundary responsibilities in our rapidly changing world should find it of great utility.

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ELECTRONIC AIDS TO NAVIGATION

THE U. S. COAST GUARD HEADQUARTERS has announced the publication of a booklet on *Electronic Navigational Aids*, including a basic description of Loran, Radar, and Raeon.

This 48-page booklet is written in non-technical language, and contains over thirty illustrations. One portion of it deals with Loran, and provides a brief sketch of the historical background, a description of the Loran system, including principles of operation, the application of Loran, a consideration of the operating range and accuracy, a summary of the most valuable features, and a brief discussion of some of the technical aspects.

The second portion of the booklet sketches briefly the history and development of Radar, with especial attention given to the study and experimental testing of Radar by the Coast Guard. The booklet also contains a technical description of Radar and its functional parts, a discussion of the factors affecting the selection of a merchant marine Radar, a brief consideration of future developments, and a glossary of terms most frequently encountered in discussing Radar.

Copies of this booklet for professional use may be obtained from the Public Information Division, U. S. Coast Guard, Washington 25, D. C., by persons interested in the development and use of these electronic aids to navigation.

CHARLES HENRY DEETZ

The death on January 27 of Charles H. Deetz brought to a close the long and distinguished service of one of the Government's outstanding cartographic engineers. Although his official work with the Coast and Geodetic Survey ended with his retirement in 1936, he never lost contact with the Bureau's cartographic activities nor with cartography in general. He was frequently consulted by personnel of the Survey on matters relating to projections, and when death came to him he was engaged in the preparation of an article on "World Mapping" for this Journal.

Charles Deetz was born at Sellersville, Pennsylvania, on April 10, 1864. He received his preparatory and professional education at the Phillips Exeter Academy, the Massachusetts Institute of Technology, and George Washington University. He began his career in Government service in 1889 as a field engineer in the Coast and Geodetic Survey and for nine years was engaged on triangulation, topographic, and hydrographic surveys in various parts of the United States—an experience which was to serve him well in his later work as cartographic engineer. In 1898 he was assigned to the Division of Charts in the Washington Office, where he served as Assistant Chief of the Cartographic Section and as Senior Research Cartographic Engineer.

During his long career in the Coast Survey—serving under eight of the thirteen Directors of the Bureau—Mr. Deetz compiled some of the most important of the Bureau's nautical charts, among them being those of New York Harbor and the Canal Zone. His artistic temperament combined with his knowledge of the practical needs of the navigator helped set the pattern and style of the present nautical chart. His intimate knowledge of the past practices of the Bureau became of great value in the interpretation of many of the early Survey records, and he was looked to as the connecting link between the Coast Survey past and the Coast Survey present.

During the later years of his service in the Coast Survey, Mr. Deetz was engaged on cartographic research. He is the author of numerous technical papers and Bureau publications dealing with nautical cartography, some of which have received international recognition. During World War I—when the French armies adopted the Lambert system of projection for their battle maps—he prepared two publications, "The Lambert Conformal Conic Projection" and "Lambert Projection Tables" (for the French war zone), which presented for the first time to American cartographers the principles and advantages of this projection. His best known contributions are "Elements of Map Projection" (co-author with Dr. O. S. Adams) and "Cartography," the former—long a Government best seller—being one of the clearest and most complete treatises on the subject in the English language. During World War II, he returned to the Bureau to bring both of these publications up to date.

In recognition of his contributions to cartography, the National Geographic Society in 1942 honored him with election to life membership in the Society.

It was a privilege to have known Charles Deetz personally and to have been associated with him professionally. During the years following the death of his wife, and up to the time of his own passing, I had occasion to visit with him frequently. I became impressed with his scholarly attainments and with his great love for the classics—a love which he carried with him to the end. I shall always remember one of my last visits with him at a hospital in Baltimore. Even while his body was racked with pain he would read passages from Homer and Chaucer and meditate over their philosophical implications.

Charles Henry Deetz—scientist, scholar, littérateur—hail and farewell!

A. L. SHALOWITZ

New Instruments and Equipment

Automatic Camera

As simple in operation as an ordinary box camera, a new ultra high-speed, high intensity, self-contained light source camera has been developed by the Army's Pictorial Service for use by the Surgeon General's office.

Although but four models of the new device are presently in existence, others are being developed. According to the War Department the new camera enables anyone to take color or black and white still pictures of the fastest action, indoors and outdoors, at distances of from 6 inches to 12 feet. Every phase of the picture-taking operation, except focusing and clicking the shutter, is absolutely automatic.—*Army and Navy Journal*, November 10, 1945.

Lettering Machine

The efficiency of the Vari-typer in speeding up lettering on all types of engineering drawings and tracings is described in a 12-page booklet issued by the Ralph C. Coxhead Corporation. The Vari-typer is the only mechanical lettering machine which handles tracings of any size, provides quickly interchangeable types in various sizes and styles, and always produces clear, legible prints. It was planned to reduce lettering time by as much as 70% and can be operated by any good typist.—*Civil Engineering*, October 1945.

Drawing and Measuring Device

Virtually eight instruments in one, Parvagraph, a new drawing and measuring device recently announced by the Para Products Company, West Haven, Conn., serves as a square, divider, protractor, triangle, ruler, compass, french curve, and mitre. It consists of two parts: a combination square and a removable mitre arm to be mounted on the square through either of two mounting holes. The mitre arm, locked at any desired position by a wing nut, can form angles of any degree; if the arm is removed and used as a radius, ½- to 14-inch diameter circles can be scribed.

This device of tough, transparent plastic is boxed, with complete instructions for use.—*Engineering News-Record*, January 10, 1946.

Adjustable T-Square

Molded of heavy, colorful, plastic, a new streamlined adjustable T-square announced by the C-Thru Ruler Company, Hartford, Conn., features a protractor graduated in degrees. Another feature is that arms of various lengths—12, 18, 24, and 30 inches—are interchangeable.

The arm permits clear visibility over the entire surface of the work, and is so fastened to the head as to pivot to any angle. It is equipped with brass lugs for ink ruling.—*Engineering News-Record*, February 7, 1946.

New Lens for Surveying Instruments

David White Company, Milwaukee, Wis., has announced a new coated lens in the manufacture of surveying instruments. This manufacturer claims that brightness is increased by as much as 40 percent and, in addition, image contrast is greatly improved. In the ordinary lens, it is estimated there is a 43 percent light loss in an internal focusing telescope. In the coated lens, light transmission is greatly increased, and the haze caused by internal reflections is reduced resulting in a brighter and sharper image. Descriptive bulletin available.—*Civil Engineering*, September 1945.

Photo Dryer

Now available is a photo dryer which operates with additional electrical heating elements that assure maintenance of even heat. It quickly dries matte or semi-matte prints or glossy prints as well as blue or black-and-white prints. Thermostatic control may be had and variable speed drive motors and controllers permit instantaneous speed changes over a range of 6 inches to 3¾ feet a minute.

A chromium plated copper drum that finishes photos with high glossy surface is included. Steel-clad, refractory insulated, nichrome heaters, nickel contacts, and asbestos insulated nickel wire are used, forming a long-lived heating and control unit. The dryer, made by Peck and Harvey, comes in 26-inch and 44-inch widths.—*Scientific American*, August 1945.

Map Information

With this issue of our Journal there is inaugurated a Map Information Department through which it is hoped to bring to the attention of the members information pertaining to the availability of maps, surveys, etc., with particular emphasis on how such material can be procured. While the first article deals with a federal agency, it is not the purpose to limit the scope of this department to federal map information. Municipal, county, state, and private surveying and mapping projects will be included. Authoritative articles covering this class of information are solicited. It is believed that through an interchange and dissemination of such information maximum benefits will accrue to the surveying and mapping profession. Comments and suggestions on this new department will be welcomed. —EDITOR.

Aerial Photographs Available from U. S. Department of Agriculture

(See Coverage Map Enclosed)

THE U. S. Department of Agriculture, in connection with its vast program relating to the marketing and distribution of agricultural products, soil and erosion control, the protection and administration of national forests, and the conservation and proper use of the land, has probably used aerial photographs more extensively than any other federal agency. During the past ten years it has secured, either directly or by contract, aerial photographs of over 70 percent of the area of the United States. This covers practically 90 per cent of the agricultural land in the country. The extent of coverage is shown by legend on a map enclosed with this issue. Reproductions of such photographs and maps are obtainable at the prices indicated below.

The photographs are of the single-lens type, and were taken in accordance with rigid federal specifications to provide adequate side and end overlap, and for the most part are on the approximate scale of 1:20,000 (1,667 feet per inch or 3.16 inches to the mile). Certain arid and semi-arid areas in the West and Southwest were photographed on the scale of 1:31,680 (2,640 feet per inch or 2 inches to the mile).

How to Order Photographs

Orders may be taken by, or order blanks obtained from, state or county offices of the Field Service Branch of the Production and Marketing Administration, and local or regional offices of the Forest Service and Soil Conservation Service. If the information desired cannot be obtained locally, or if it is not known which bureau has the negatives, orders or inquiries should be addressed to the Office of Plant and Operations, Department of Agriculture, Washington 25, D. C. Photographs must be identified by designating alphabetical symbol, roll, and exposure numbers which can be obtained from the above field offices. Normally orders are filled within 30 days after receipt.

Payment for photographs should accompany the order and should be by check, money order, or draft, payable to the *Treasurer of the United States* and forwarded to the agency from which photographs are ordered. Stamps are not acceptable.

Prices for Reproductions

The prices listed below are for items most generally requested. Prices for other available items will be furnished upon request.

CONTACT PRINTS

The following prices are for contact prints of various sizes. The size in each case refers to the approximate size of the negative. Contact prints will be trimmed if so specified.

Quantity	Size of Negative in Inches	
	7 by 9 9 by 9	10 by 10 10 by 12
	*Price each**	*Price each**
1–5	$0.60	$0.80
6–100	.35	.45
Over 100	.30	.30
County coverage	.25	.25

* For waterproof (low-shrink) paper, add $0.10 per print.

Aerial Photo-Indexes

Quantity	*Price per sheet*
Any number	$0.90

ENLARGEMENTS

The following prices are for enlargements (projection prints) made from 7 by 9 or 9 by 9 inch negatives. The size in each case refers to the approximate size of paper required to produce the enlargement ordered and not to the negative size. Enlargement factors must be furnished with each order.

Quantity	Size of Paper in Inches			
	11 by 14 14 by 14	16 by 20	20 by 24 25 by 25 20½ by 26 27 by 28 22 by 27	28 by 34 34 by 40 40 by 40
	Price each	*Price each*	*Price each*	*Price each*
1–5	$1.00	$1.15	$1.75	$4.60
6–100	.60	.70	1.25	2.90
Over 100	.50	.60	1.00	2.30
County coverage	.45	.....	.85	2.00

Single or double weight paper not ferrotyped (double weight, semi-matte will be furnished unless otherwise specified). All contact prints and enlargements are unmounted; and all except 7 by 9, 9 by 9, 10 by 10, or 10 by 12 inches are untrimmed.

(County coverage is defined as coverage of an entire county or of such part of a county contained within a certain aerial photographic project. Such coverage may be either stereoscopic or non-stereoscopic, but must be specified in the order.)

PUBLIC ROADS ADMINISTRATION MAPS

A REVISED EDITION of the California transportation map, consisting of 21 sheets, has been prepared by the Public Roads Administration of the Federal Works Agency for general distribution. The map, drawn to a scale of four miles to the inch, shows in color the location and character of all state and federal-aid highways, important secondary road connections, airports, canals, navigable streams, and other transportation facilities in California. Boundaries of national and state forests and parks, Indian reservations, wild-life refuges and recreational areas, and roads leading to them, also are shown. The highway information was prepared by the cartographic section of the P.R.A. and superimposed upon base maps compiled by the U. S. Geological Survey.

The California map is one of a series of state transportation maps which the Public Roads Administration has issued at intervals since 1936. Maps have been published for 26 states. Maps for 11 other states are in process of compilation or awaiting final printing. They are printed on sheets of uniform size, 26 by 36 inches, and are too large to be used conveniently for touring. They are designed primarily for use by the War Department and other government agencies, and by state and county highway engineers and planning agencies.

Copies of the California map may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. The price for the complete set of 21 sheets is $5.50. A limited supply is reserved by the Public Roads Administration for distribution to qualified educational institutions, public libraries, and state and county officials.—*Civil Engineering*, September 1945.

PRICE LISTS OF GOVERNMENT PUBLICATIONS

Price lists of government publications covering the fields of "Engineering and Surveying," "Maps," and "Geography and Exploration," are available for free distribution from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. These lists may serve as valuable check lists to engineers engaged in surveying and mapping work who wish to keep in touch with the latest developments in their fields.

Comment and Discussion

The pages of SURVEYING AND MAPPING are open to a free and temperate discussion of all matters pertaining to the interests of the CONGRESS. It is the purpose of this Department to encourage comments on published material or the presentation of new ideas in an informal way. —EDITOR.

THE METER

H. R. EDMONSTON.*—The metric system of measures originated in France about 1736. It was then supposed to have been one ten-millionth of the length of the quadrant of the meridian which passes through Paris. According to that determination, a meter is equal to 39.37079 inches. In spite of the fact that the measurement of the earth's quadrant on which the meter was based was later proved to be inaccurate, the meter remained the length as preserved in Paris.

In 1866, Congress authorized the use of the metric system in this country, and directed that the new five-cent piece be one-fiftieth of a meter in diameter. In 1893 the Secretary of the Treasury formally approved the recommendation of the Superintendent of Weights and Measures to make the meter the fundamental unit and to derive the yard from it, in accordance with the Act of 1866. As a result the yard was defined as $\frac{36}{39.37043}$ of a meter.

But where did the yard originate as a unit of length? It appears that in early times short distances were measured by the breadth of the finger or length of the forearm. A finger breadth was called a digit; the Roman digit was about 0.73 of an English inch. A cubit was the length of the arm from the elbow to the end of the middle finger. From measuring rods found in the tombs of Egypt, the Egyptian cubit is known to have been equal to 17.4 inches. The foot as a unit of length probably originated in Greece, where the Olympian foot is said to have been the length of the foot of Hercules. In the year 1101 the length of the arm of Henry I became the British yard.

In an attempt to establish a reliable standard yard, a committee of the Royal Society in 1742—after comparing all existing standard yards—selected one found in the Tower of London. In 1855 the present Imperial Standard yard was constructed from one belonging to the Astronomical Society which was the one recognized by the Standards Commission of 1818.

In this country many of the colonial legislatures adopted the British standards. In 1814, Ferdinand R. Hassler, while in London purchasing instruments for the Coast Survey, obtained from Mr. Troughton—a maker of fine instruments—a standard yard scale and brought it to this country the following year.

When an examination in 1830 found serious discrepancies in the yard used in the various custom houses of the country, the Treasury Department adopted the Troughton scale, and deposited copies of it with the governor of each state. Later more accurate copies of the British Imperial Standard were received in this country.

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* Assistant Chief, Nautical Chart Branch, U. S. Coast and Geodetic Survey.

As the metric system is coming more and more into use, it is well that the yard is defined in terms of meters.

ENCOURAGEMENT

I want to express my delight at the appearance and quality of the recent issues of the Journal—especially the July issue. It is rapidly assuming a leading place among similar publications. The scope and character of the articles are excellent and the magazine and book notices bring all of the current literature within easy purview of the reader. I have enjoyed especially the histories of the various federal surveys.

I am glad a membership campaign is under way which we all hope will bring to a much larger number of members the benefits of the Congress and the Journal.—PROF. W. H. RAYNER, Vice President, Region 4.

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New Engineering Definitions Proposed

DURING THE PAST YEAR, new definitions of "professional engineer" and of the "practice of engineering" were considered by the principal engineering societies of the country. The need for better definitions than those commonly used in registration laws was indicated when the Illinois Supreme Court, in 1944, declared the new engineer license law for that state unconstitutional and criticized the definition of professional engineering in the registration law as being so all-inclusive as to be no definition at all.

To remedy these shortcomings the American Society of Civil Engineers, in co-operation with representatives of leading engineering societies, has drawn up and submitted to the societies for adoption the following definitions:

"*Professional Engineer*—The term professional engineer within the meaning and intent of this act shall mean a person who, by reason of his special knowledge of the mathematical and physical sciences and the principles and methods of engineering analysis and design, acquired by professional education and practical experience, is qualified to practice engineering as herein defined, as attested by his legal registration as a professional engineer.

"*Practice of Engineering*—The term practice of engineering within the meaning and intent of this act shall mean any professional service or creative work requiring engineering education, training and experience, and the application of special knowledge of the mathematical, physical, and engineering sciences to such professional services or creative work as consultation, investigation, evaluation, planning, design, and the supervision of construction for the purpose of assuring compliance with specifications and design, in connection with any public or private utility, structure, buildings, machines, equipment, processes, works, or projects."—*Engineering News Record*, January 24, 1946.

CONGRESS NEWS

Committee on Municipal and County Engineering Surveys Authorized

EDITOR'S NOTE.—The overall program of The American Congress on Surveying and Mapping was considerably enlarged and strengthened on January 22, 1946, when, with unanimous approval of the Executive Committee, an Interim Committee on Municipal and County Engineering Surveys was authorized. Joseph M. Dearborn, Director of The Bridgeport Geodetic Survey, a branch of the City Engineer's Office in Bridgeport, Connecticut, was appointed Chairman. Mr. Dearborn's statement on the plans for his Committee follows:

I was greatly impressed by the enthusiasm that was in evidence at the authorization meeting in Washington. It was felt that it would be premature to attempt to organize at this time a full Technical Division, without first polling the interested members of the CONGRESS and consolidating their ideas, suggestions, comments, and many divergent interests into a workable, worthwhile organization. However, it is planned to bring into being a permanent Technical Division, concerned with municipal and county engineering surveys, immediately upon receipt of sufficient interest and data to insure its permanency.

This Division of the CONGRESS will concern itself with surveying and mapping problems of the city, metropolitan, and county engineers, with emphasis on horizontal and vertical control, topographic, planning, construction, underground structures, street line or right of way, assessment and zoning surveys and mapping, and other related surveys of general interest.

The immediate plans call for the gathering and insertion in SURVEYING AND MAPPING of several original and interesting articles, by members of the CONGRESS and others, on various phases of municipal and county engineering. Comments, suggestions, and evidence of interest in the formation of the Technical Division are cordially invited. The Chairman, in addition to organization plans, has assumed the responsibility for assembling, editing, and forwarding this material to the EDITOR of SURVEYING AND MAPPING, and all such material should be routed through him until a permanent division is organized. It is extremely desirable to hear from every member of the CONGRESS, whose particular interests lie in this specialized field of surveying and mapping.

Upon the permanent formation of the Technical Division, one more strong link in the organizational chain of the CONGRESS will be forged. From the divisions of interest to the federal agencies—on a national scale—and to the private surveyors—on a local scale—a constant flow or interchange of ideas, an improvement in technical procedures and specifications, and a general uplifting of the whole profession will be the inevitable result. The potential possibilities for good are almost beyond imagination.

If you can contribute toward a realization of these objectives, do so, and fulfill your professional obligation.

JOSEPH M. DEARBORN,
Chairman.

A LOCAL SECTION FOR WASHINGTON

Members of the American Congress on Surveying and Mapping residing in the Washington area met on March 15 to discuss the desirability of forming a local section. Approximately 150 members and guests attended including representatives of the federal surveying and mapping agencies, the American Society of Photogrammetry, and private practice concerns.

Considerable enthusiasm was expressed by those who spoke on the proposal and it was brought out that such a section would provide a medium for local groups—whose major interests lie in the surveying and mapping field—to become better acquainted; would provide a forum for the interchange of practices in chart and map work; and would afford an opportunity for presenting and developing new ideas in surveying and mapping. It was also emphasized that such a section would provide source material for our Journal, would develop leadership in the Congress, and would serve as a stimulus for the establishment of other local sections.

A committee, headed by Mr. Marshall S. Wright, Vice President of Region 2, was named to effect the organization of the Section.

PUBLICATIONS COMMITTEE

The following are members of the present Committee on Publications for the CONGRESS:

Walter S. Dix, Tennessee Valley Authority
Charles F. Fuechsel, Geological Survey
Jerome O. Kilmartin, Geological Survey
Chester H. Ober, New York Manager, *Iron Age*
Robert H. Randall, Bureau of the Budget
Aaron L. Shalowitz, Editor, SURVEYING AND MAPPING
Albert A. Stanley, Coast and Geodetic Survey
George D. Whitmore, Geological Survey, *Chairman*

CARTOGRAPHY COURSE PROPOSED

Through the representation of the American Congress on Surveying and Mapping, the Graduate School of the U. S. Department of Agriculture is considering the advisability of instituting a course in "Cartography" next fall.

The proposed course would extend for two semesters, with sessions of 2 hours a week in each semester, and would include a history of maps with emphasis on the influences of the early cartographers in contemporary map making; a study of the various Federal surveys—their authorization, history, and jurisdiction;

basic field data required for cartographic compilation; electronics in mapping; the elements of map projection; the use of grids including the State Coordinate Systems; and compilation and reproduction of maps and charts including methods of cartographic representation, the use of plastics, and gradient tints.

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"Science—The Endless Frontier"

(EXTRACT FROM A REPORT TO THE PRESIDENT BY DR. VANNEVAR BUSH, DIRECTOR, OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT)

Background Research

The preparation of accurate topographic and geologic maps, the collection of meteorological data, the determination of physical and chemical constants, the description of species of animals, plants, and minerals, the establishment of standards for hormones, drugs, and X-ray therapy; these and similar types of scientific work are here grouped together under the term background research. Such background knowledge provides essential data for advances in both pure and applied science. It is also widely used by the engineer, the physician, and the public at large. In contrast to pure science, the objectives of this type of research and the methods to be used are reasonably clear before an investigation is undertaken. Thus, comprehensive programs may be mapped out and the work carried on by relatively large numbers of trained personnel as a co-ordinated effort.

Scientific work of this character is necessarily carried on in all types of research organizations—in universities, in industry, and in Government bureaus. Much of it evolves as a necessary byproduct either of applied research or of development. Only very rarely, however, does the knowledge obtained emerge in patentable form and the public welfare is usually best served by prompt publication of the results.

There seems to be little disagreement with the view that these surveys and descriptions of basic facts and the determination of standards are proper fields for Government action and that centralization of certain aspects of this work in Federal laboratories carries many advantages. There are few private organizations equipped to carry out more than a small fraction of the research needed in these fields. And it is obvious, for example, that topographic maps are most useful when maps for the entire country observe similar rules in regard to scale, contour lines, conventional markings for roads, dwellings, etc. Similarly, standard units for hormones should be based on uniform test procedures and be stated, so far as is possible, in uniform units. The Federal Government has recognized these responsibilities in principle, and the Bureau of Standards serves as an excellent example of how such work can be carried out most efficiently.

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THE "C. S. HAMMOND SCHOLARSHIP IN CARTOGRAPHY"

A scholarship at Northwestern University, designated the "C. S. Hammond Scholarship in Cartography," has been established by C. S. Hammond & Company, map publishers, New York, to assist talented students in the field of map making and associated arts.

NEW MEMBERS

AGUILAR V., DANIEL
Major, Instituto Geográfico Militar, Avenida "Frias" 261, La Paz, Bolivia

ALVAREZ-GUTIERREZ, ING. EDWARDO
Director, Instituto Geográfico Militar y Catastral, Bogota, Colombia, S.A.

ALTENHOFEN, ROBERT E.
Major, Photogrammetrist-Topo. Engr., Army Map Service, Washington, D. C.

AMES, ARTHUR JOHN
Managing Director, Instruments Limited, 240 Sparks St., Ottawa, Ontario, Canada

ANDERSON, A. GORDON
Lieutenant (jg), U. S. Coast & Geodetic Survey, Seattle 4, Washington

ANDREGG, CHARLES H.
Cartographic Engr., U. S. Corps Engrs., Army Map Service, Washington, D. C.

ARGYROPAIS, LEMONIS J.
Cartographic Engr., Alaskan Branch, U. S. Geological Survey, Wash., D. C.

ARNESON, CLAIR L.
Civil Engineer, Photogrammetric, U. S. Forest Service, Gettysburg, Pa.

ASHCRAFT, O. L.
Licensed Surveyor, 226 Martinsburg Road (R.D. 3), Mt. Vernon, Ohio

ASHER, JOHN E.
Ch. Draftsman, Gen. Petroleum Corp., 108 W. 2nd. St., Los Angeles 12, Cal.

BARCLAY, LELAND
Asst. Professor of Civil Engineering, University of Texas, Austin, Texas

BARRETTE, GERALD, (Q.L.S.)
Inspector of Surveys, Dept. of Lands and Forests, Quebec Govt., Quebec, Canada

BARTLETT, FORD
Pres., Lockwood, Kessler and Bartlett, Inc., 32 Court St., Brooklyn, N. Y.

BASS, LEO
Photogrammetrist, Hydrographic Office, Suitland, Maryland

BEAN, HAROLD A.
Assoc. Topo. Engr., U. S. Geological Survey, Topographic Branch, Wash., D. C.

BEAVIN, B. EVERETT
Assoc., J. E. Greiner Co., Consulting Engr., 1201 St. Paul St., Baltimore, Md.

BELANGER, HENRI
Quebec Land Surv., Dept. of Lands and Forests, Quebec Govt., Quebec, Canada

BENDER, THOMAS FRANCIS
Surveyor, 655 King Street, Lancaster, Ohio

BENTON, LEICESTER F., JR.,
Sr. Highway Engr., State Highway Dept., Room 311, Thayer Bldg., Norwich, Conn.

BERNSTEIN, EDGAR H.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Washington, D. C.

BIGGS, ARTHUR P.
Ch., Latin Amer. Unit, Map Intelligence Section, Dept. of State, Wash., D. C.

BIRNBAUM, HARRY
Head Civil Engineer, U. S. Engineers Ohio River Div., Columbus, Ohio

BLANCHARD, ROBERT G.
Topo. Engr., Dept. of Conservation, State House Annex, Trenton, N. J.

BRITCHER, KARL E.
Surveying Instruments,
3012 Cresmont Ave., Baltimore, Md.

BROSGE, WILLIAM P.
Topographic Engineer, Alaskan Branch, U. S. Geological Survey, Wash., D. C.

BUCKMASTER, J. L.
Mech. Engr., Div. of Field Equipment, U. S. Geological Survey, Wash., D. C.

BUSH, ARTHUR V.
Chief of Party, Public Works, Navy, 809 Kinau St., Honolulu, T. H.

CABOT, EDWARD C.
Engineering Draftsman, Alaskan Branch, U. S. Geological Survey, Wash., D. C.

CALDER, WILLIAM D.
Cartographer, Army Map Service,
6101 MacArthur Boulevard, Wash, D. C.

CAMPBELL, JACK V.
Engineering Draftsman, U. S. Coast & Geodetic Survey, Washington, D. C.

CARTER, TRUMAN F.
Cartographer, U. S. Coast & Geodetic Survey, Washington, D. C.

CLARK, CHARLES W.
Lieutenant, U. S. Coast & Geodetic Survey, Washington, D. C.

CLARKE, GEORGE A.
Office Engineer,
Box 25, Harrison, Nebraska

COLLINS, W. JOHN
Survey Party Chief, Transitman,
R.D. 2, Barnesville, Ohio

CONNER, HENRY W.
Vice Pres., H. M. White Surveys,
24 Commerce Lane, Rockville, Maryland

CRANGLE, DALE E.
Assoc. Topo. Engr., U. S. Geological
Survey, Rolla, Missouri

DALLYN, GORDON M.
Editor, The Canadian Geographical
Journal, Ottawa, Ontario, Canada

DAVIS, JOHN M.
Mining Engr. and Surv., Hanna Coal Co.,
Main Street, St. Clairsville, Ohio

DEEG, JAMES J.
Photogrammetric Engr., Mapping &
Charting Br., AAF, Wright Field, Ohio

DILL, PHILIP A.
Assoc. Photogrammetrist,
U. S. Hydrographic Office, Suitland, Md.

DILONARDO, AGAPITO L.
Engr. Aide, Photogrammetry, Alaskan Br.,
U. S. Geological Survey, Wash., D. C.

DINGMAN, LESTER F.
Asst. Topo. Engr., U. S. Geological
Survey, Arlington, Virginia

DIXON, CHARLES M.
Civil Engineer, 2911 10th Avenue,
Columbus, Georgia

DOFFLEMYER, CLYDE E.
Draftsman, Unit Chief, U. S. Army Air
Forces, BG 934, The Pentagon, Wash., D. C.

DUPUY, EDMUND P.
Surveyor, Aero Service Corp., 236 East
Courtland Street, Philadelphia, Pa.

DURGIN, CASPER M.
Lieutenant Commander, U. S. Coast &
Geodetic Survey, Washington, D. C.

ELDRIDGE, WESLEY C.
Surveyor, Project Chief, 236 East
Courtland St., Philadelphia 20, Pa.

ENGEN, GILBERT A.
Cartographer, U. S. Hydrographic Office,
Navy Department, Suitland, Md.

EVERETT, GEORGE H.
Cartographic Engineer, U. S. Coast &
Geodetic Survey, Washington, D. C.

FLINT, GEORGE M.
Geologist, Alaskan Br., U. S. Geological
Survey, Washington, D. C.

FOSS, RAY J.
Asst. Prof., Civil Engineering Dept.,
Univ. of Louisville, Louisville, Ky.

FRIEDMAN, HAROLD J.
Engr.-Dir. and Consultant, Public Works
Panel, Glynn County C. H., Brunswick, Ga.

FROBERG, GERALD A.
Civil Engineer, Dept. of Public Works,
Bureau of Engineering, Chicago, Ill.

FULLER, E. W.
Chicago Aerial Survey Company,
332 S. Michigan Ave., Chicago, Ill.

GAVRISHEFF, BORIS J.
Cartographer, U. S. Hydrographic Office,
2804 Naylor Road, Washington 20, D. C.

GEORGE, VERNON D.
Seybolt & George, Civil Engrs. & Land
Survs., 2223 R St., S.E. Wash., D. C.

GOULD, ROBERT S.
Lieutenant, Bureau of Ordnance,
U. S. Navy Department, Washington, D. C.

GREEN, CHARLES KEITH
Comdr., Chief, Division of Tides, U. S.
Coast & Geodetic Survey, Wash, D. C.

GREENBERG, ISIDORE
Teacher, Physical Science, Thomas
Jefferson High School, Brooklyn, N. Y.

GRENELL, S. B.
Lieutenant Commander, U. S. Coast &
Geodetic Survey, Seattle, Washington

GRIFFIN, EDNA MARJORIE
Engr. Draftsman, U. S. Geological Survey,
Washington, D. C.

HARPSTER, ROBERT A.
Reg. Land Surv., Jones and Harpster,
Route 1, Box 328, Clackamas, Oregon

HAYNE, H. M.
Ch., State Lands Sect., Dept. of Public
Works, State Capitol, Baton Rouge, La.

HAYS, LAWRENCE A.
Cartographer, Army Map Service,
Washington, D. C.

HELLMAN, WILBERT M.
Lieutenant (jg), U. S. Coast &
Geodetic Survey, Seattle, Washington

HOFF, CLARENCE W.
Asst. Carto. Editor, U. S. Geological
Survey, Arlington, Virginia

HOKE, WILLIAM B.
Prin. Asst. Supt. of Surveys, Bureau of Plans & Surveys, Baltimore, Maryland

HOOKS, W. R.
Assistant City Engr., City of Gadsden, Gadsden, Etowah County, Alabama

IVES, C. D.
City Engineer, City of Asheville, 401 Court House, Asheville, N. C.

JEFFERS, KARL B.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Seattle, Washington

JOHNSTON, SAMUEL A., JR.,
Engr. Aide, Trimetrogon Unit, U. S. Geological Survey, Arlington, Va.

JONES, MYRON T.
Consulting Engineer, 2607½ North High Street, Columbus 2, Ohio

KILGORE, LEE W.
Major, Ch., Evaluation Sect., Photo. Br., AAF, 628 S. 13th St., Chickasha, Okla.

KING, W. MATSON
Soil Conservation Surv., Surveying, U. S. Dept. of Agriculture, Ripley, W. Va.

KINGSLEY, DUMONT T.
Gehres and Kingsley, Surveyors, 415 First-Central Tower, Akron, Ohio

KISTLER, PHILLIP S.
Photogrammetrist, Chicago Aerial Survey Corp., 215 W. Ohio St., Chicago, Ill.

KLINE, HIBBARD V. B., JR.,
Lieut. (jg), Ch., Carto. Sect., IRIS, Office of Strategic Serv., Wash., D. C.

KRELL, BERT B.
Sr. Planning Draftsman, City of Los Angeles, City Hall, Los Angeles, Cal.

LASKOWSKI, JOHN
Lieutenant Commander, U. S. Coast & Geodetic Survey, Seattle, Washington

LEE, ROBERT O.
Cartographic Engineer, U. S. Coast & Geodetic Survey, Washington, D. C.

LOUD, EDWARD I., JR.,
Photogrammetric Engineer, U. S. Geological Survey, Arlington, Va.

LUEDTKE, WILLIAM
Engineering Draftsman, U. S. Coast & Geodetic Survey, Washington, D. C.

MACE, MARGARET
Carto., Ast. Ch., Graphic Sect., Joint Intelligence Study Pub. Bd., Wash., D. C.

MALNATE, WILLIAM F.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Seattle, Washington

MALTBY, CALVIN S.
Topographic Engineer, U. S. Geological Survey, Washington, D. C.

MANSFIELD, FRANCIS K.
Lieut. (jg), U. S. Naval Air Station, 155 Upsal St., S.E., Washington, D. C.

MARSDEN, LLOYD E.
Govt. Engr., U. S. Geological Survey, Box 133, Rolla, Missouri

MARTIN, ROBERT J.
Topographic Engineer, U. S. Geological Survey, Topo. Br., Arlington, Va.

MATHENY, WILLIAM R.
Supervisor, Alaskan Br., U. S. Geological Survey, Washington, D. C.

MATZKO, JOHN J.
Engineering Aide, Alaskan Branch, U. S. Geological Survey, Wash., D. C.

McDONALD, EMMET J.
Civ. Engr. and Surv. (Private Practice), 640 North Main Street, Akron, Ohio

McDONALD, JAMES E.
Civil Engineer, McDonald and McDonald, Engrs., Knoxville, Tennessee

McPHEETERS, DOROTHY C.
Cartographic Engineer, U. S. Coast & Geodetic Survey, Washington, D. C.

MEREDITH, GUY P.
Cartographer, U. S. Coast & Geodetic Survey, Washington, D. C.

METELITS, JEROME B.
Aerial Photog. and Photogr., 524 Engr. Topo. Co., c/o P.M., San Francisco, Cal.

MILLAS, ROLANDO
Dr., Prof. en la Escuela de Agrimensura de La Habana, Cuba

MONDAY, FRANK E.
Photogrammetric Engr., U. S. Geological Survey, Arlington, Virginia

MONROE, CLARENCE A.
Chief Engineer, Levitt & Sons, Inc., Northern Boulevard, Manhasset, N. Y.

MOON, HARRY E.
Cartographic Engineer, Army Map Service, 6101 MacArthur Boulevard, Wash., D. C.

MORRISS, GROVER C.
Prof. Eng., Ch. Engr., Gen. Land Office, 912 Trinity Street, Austin, Texas

MORROW, JAMES T.
Prin. Engr. Draftsman, U. S. Coast & Geodetic Survey, Washington, D. C.

MUNDINE, JESSIE E.
Cartographic Engineer, Alaskan Branch, U. S. Geological Survey, Wash., D. C.

NEWLIN, DELMAS B.
Associate Mathematician, U. S. Coast & Geodetic Survey, Washington, D. C.

OROS, CHARLES N.
Associate Engineer, Photogrammetry, U. S. Engineers, Oswego, Oregon

OWENS, WILLIAM EVAN
Ch. Engr., Water & Engr. Section, 779 Oxford St., Worthington, Ohio

PANTALEO, THEODORE T.
Registered Land Surv. Asst. Road Engr., Anne Arundel County, Annapolis, Md.

PEACOCK, FREDERIC L.
Commander, Hydrographic and Geod. Eng., U. S. Coast & Geodetic Survey, Balto., Md.

PEARCE, FLETCHER
Head of Civil Engineering, Northern Montana College, Havre, Montana

PEED, JOHN R.
Draftsman, U. S. Coast & Geodetic Survey, Washington, D. C.

PENNINGTON, JOHN T.
Civil Engineer, Mapping Branch, Engineer Board, Fort Belvoir, Virginia

PENNY, FRANK C.
Frank C. Penny, Engineering and Surv., 83 Fairfield Ave., Bridgeport, Conn.

PERKINS, BASIL C.
Highway Engineer and Land Surveyor, Boundary Avenue, Elkins, West Va.

PEYTON, GARLAND
Capt., State Geol., Dir., Georgia Dept. of Mines, Mining & Geology, Atlanta, Ga.

PIERCE, BEN
Deputy County Engineer, County Engineers Office, Court House, Xenia, Ohio

RASURE, WILLIAM A.
Photogram. Engr., U. S. Coast & Geodetic Survey, Tampa, Florida

REED, CLARENCE R.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Washington, D. C.

REED, THOMAS B.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Washington, D. C.

RICHARDSON, J. MAC
Supt. of Streets, City Hall, Greenville, South Carolina

RODRIGUEZ, LYSANDRO VIANNA
Brazilian Govt. Off., Div. of Geodesy, U. S. Coast & Geodetic Surv., Wash., D. C.

ROLETTI, JULIO C.
Captain of Artillery, 2007 Mass. Ave., N.W., Wash., D. C.

ROUDABUSH, MARTIN A.
Topographic Engineer, U. S. Geological Survey, Arlington, Virginia

ROWE, T. DONALD
Land Surveying (Private Practice), 97 Roosevelt St., Bridgeport, Conn.

RUBIO, ENRIQUE G.
Director Aerial Map Office, Dept. of Interior, San Juan, Puerto Rico

RUDOLPH, HARRY R.
Photogrammetric Aide, Supervisor, U. S. Coast & Geodetic Survey, Balto., Md.

SAMUEL, CEDRIC B.
Asst. Cartographic Engineer, U. S. Coast & Geodetic Survey, Wash., D. C.

SCHINDLER, EDWARD J.
Land Surveyor, 135 Sherwood Ave., Bridgeport, Conn.

SCHOFIELD, ROY M.
Provincial Land Surveyor, Dept. of Lands and Forests, Halifax, Nova Scotia

SCHONE, HAROLD K.
County Surveyor, Court House, Kansas City, Kansas

SCHUCH, EDWARD A.
Photogrammetrist, Ch. Engr., Aero Service Corp., Philadelphia, Pa.

SCOTT, E. LEE
Private Civil Engr., 8604 Rugby Drive, Hollywood, Cal.

SCOTT, RICHARD JOSEPH
Topo. Engr. and Land Surveyor, P. O. Box 383, Montrose, Ala.

SEABORN, JOSEPH, JR.
Surv. and Supt. of Schools, Lincoln Ave., Mineral Ridge, Ohio

SHELTON, CLARENCE A.
Assoc. Geod. Engr., U. S. Coast & Geodetic Survey, Washington, D. C.

SIMMERMON, ROBERT B.
Transitman, Glassboro Road, Williamstown, New Jersey

SKELTON, RAY H., II
Lieut. 64th Engr., Topo. Br., A.P.O. 181 Tokyo, c/o P.M. San Francisco, Cal.

SKOP, JACOB
Cartographer, Chief of Map Design, Army Map Serv., War Dept., Washington, D. C.

SMITH, ASA HARTUNG
Carto. Officer, Hydrographic Office, U. S. Navy Dept., Washington, D. C.

SMITH, JOSEPH F. W.
Topographic Engineer, U. S. Geological Survey, Box 133, Rolla, Missouri

SMITH, W. SHERMAN
Asst. Prof. of Civil Engr., University of Toledo, Toledo, Ohio

SOLLINS, ALFRED D.
Mathematician, U. S. Coast & Geodetic Survey, Washington, D. C.

STANLEY, ALBERT A.
Cartographic Engineer, U. S. Coast & Geodetic Survey, Washington, D. C.

STEPHENS, G. W., JR.
Civ. Engr., George William Stephens, Jr. and Assoc., Jenifer Bldg., Towson, Md.

STEWART, C. W.
Engineer, Head of Survey Section, U. S. Engineer Office, Galveston, Texas

STOUT, DAVID L.
Asst. Civil Engineer, Highway Dept. of New Jersey, Trenton, New Jersey

STREETER, GAYLORD H.
Cartographic Engineer, U. S. Coast & Geodetic Survey, Washington, D. C.

STROUP, R. K.
Engr., Eagle Picher Mining and Smelting Co., Cardin, Oklahoma

STUDDS, R. F. A.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Seattle, Washington

SUNDERLAND, JAMES E.
Field Engr., Baltimore and Ohio R. R., Baltimore & Ohio Bldg., Baltimore, Md.

SUPP, CARL W. A.
Asst. Engr., J. E. Greiner Co., Constr. Engrs., 1201 St. Paul St., Baltimore, Md.

TAYLOR, BRADFORD P.
Topographic Engineer, U. S. Geological Survey, Washington, D. C.

THOMAS, CHARLES M.
Lieut. Comdr., Hydro. and Geod. Engr., U. S. Coast & Geodetic Survey, Wash., D. C.

THORNE, SAMUEL, JR.
Map Editor, C. S. Hammond & Co., 88 Lexington Avenue, New York, N. Y.

THURMOND, JAMES D.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Norfolk, Va.

TULLIS, EDWARD J.
Ch., Tilt and Azimuth Sect., Alaskan Branch, U. S. Geol. Surv., Wash., D. C.

WAKENIGG, JOHN H.
Engr. and Supt., Pascona Bros., Inc., 155 Island Brook Ave., Bridgeport, Conn.

WALDREN, CY S.
City Surveyor, City Service Dept., Chillicothe, Ohio

WALKER, CHARLES D.
Ch. Engineer, The Sunday Creek Coal Co., Public Square, Nelsonville, Ohio

WALKER, WATSON
City Engineer, City of Macon, City Hall, Macon, Georgia

WANG, CHIH-CHO
Maj. Gen., Dir., Office of Land Surv., Chinese Military Office, Wash., D. C.

WEBB, JOHN A.
Geodetic Engineer, U. S. Coast & Geodetic Survey, Washington, D. C.

WEIDNER, ROLAND W.
Project Chief, Aero Service Corp., 236 E. Courtland St., Philadelphia, Pa.

WEINEL, JOHN E.
Civil Engr. & Surv., (Private Practice), 3219 Forest Place, East St. Louis, Ill.

WESTRATER, CHARLES W.
Cartographer, Army Map Service, 6101 MacArthur Blvd., Washington, D. C.

WILDER, LEO C.
Lieutenant Commander, U. S. Coast & Geodetic Survey, Seattle, Washington

WILLIS, JOHN E.
Astronomer and Development Engr., David White Co., Milwaukee, Wisconsin

WING, ROBERT L.
Topo. Engr., Div. of Water Resources, 401 Pub. Works Bldg., Sacramento, Cal.

WYATT, A. G. M.
Rear Admiral, Hydro., Hydro. Dept., Admiralty, Cricklewood, London, N.W.2.

YOUNG, C. ADDISON
Civ. Engr. and Surv., (Private Practice), 10 Fiske Place, Mount Vernon, N. Y.

ZARUR, JORGE
Dr., Asst. Dir., Conselho Nacional de Geographia, Rio de Janeiro, Brazil

ZARY, THOMAS A.
Civil Engr. in Topography, U. S. Forest Service, Gettysburg, Pennsylvania

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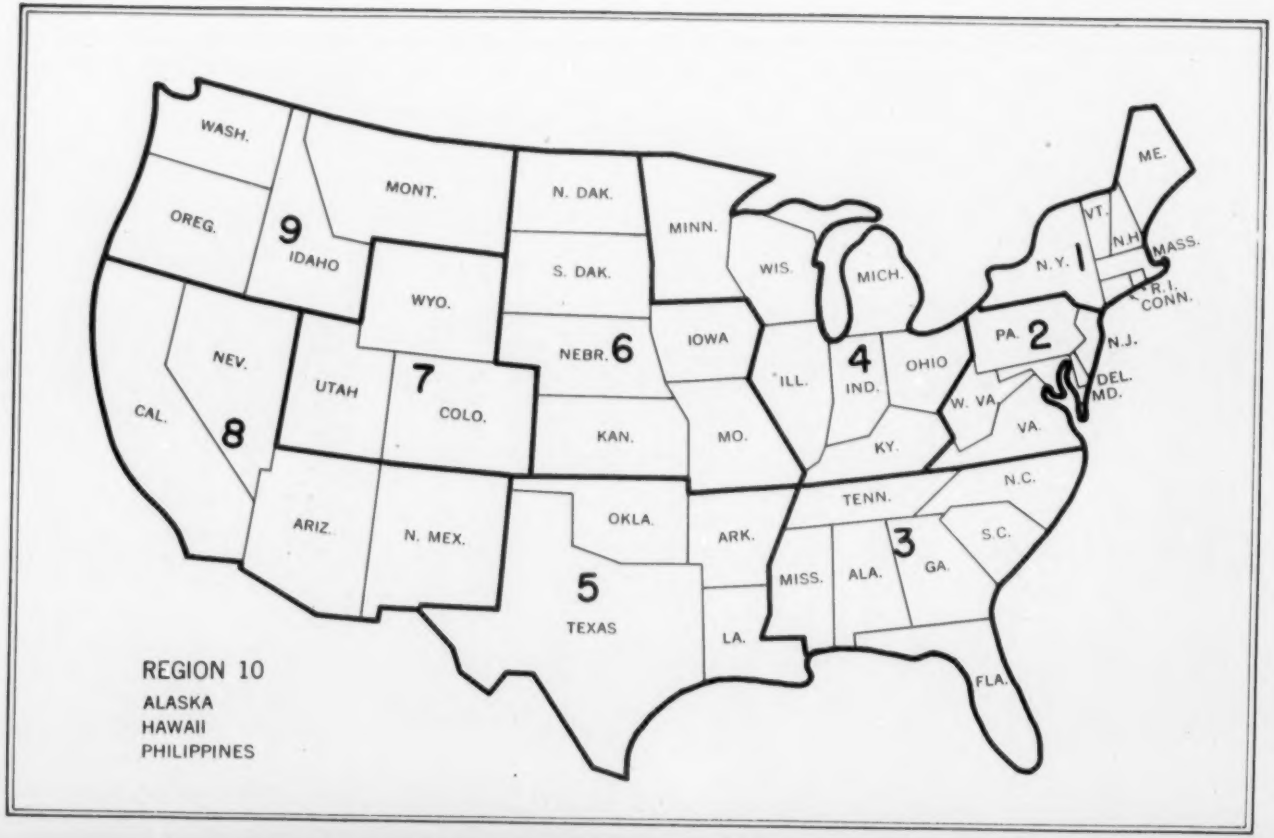

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